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CONTENTS

EDITORIALS:
Supporting the Sides of Wooden Gondolas 455
Accidents Due to Locomotive Failures 455
Modern High Speed Steel 456
The Ultimate Locomotive Stoker 456
Advantages of Large Water Capacity for Tenders 457
The Shop Crafts Strike 457

GENERAL:
Injuries from Locomotive Failures 459
Standardization in France and Belgium 463
Equated Tonnage and Fuel Consumption 464
Mechanical Stoking of Locomotives 465
Railroad Administration News 470

CAR DEPARTMENT:
The Operation of the Standard "D" Coupler 473
The Measurement of Piston Travel in Yards 474
C. P. R. Double Sheathed Box Cars 475
Specifications for Plates for Forge-Welding in Tank Car Construction 477
Durability of Steel Ends and Steel Roofs 478
What is Modern Malleable Iron 479

SHOP PRACTICE:
Electric Arc Welding Apparatus 483
Depth of Cut for Wheel Lathe 484
Repairing Lubricator Choke Plugs 484
Jacobs-Shubert Firebox Repairs 485
Removing Dowel From Air Pump Reversing Valve Bushings 487
A Boiler Check Casing with Gasket Joint 487
Automatic Self-Draining Globe Valve 488
A Special Valve Bushing Design 488
Modern High Speed Tool Steel 489
Reclaiming Air Brake Hose 492
Air Jack for Lifting Wheels 493
Bending Stirrup Brake Hangers in a Bulldozer 493
Essential Factors in Promoting Shop Output 493

NEW DEVICES:
An Open Type Locomotive Feedwater Heater 495
M. C. B. Standard Hose Coupling and Packing Ring Gages 496
A 96-in. Engine Lathe 497
A Locomotive Pulverized Fuel Equipment 498
The Lumsden Oscillating Tool Grinder 500
The Edlund Detachable Broom Head 501

GENERAL NEWS:
Notes 502
Personal Mention 504
Supply Trade Notes 506
Catalogues 508

Supporting the Sides of Wooden Gondolas

During the period when the shortage of cars for the coal traffic was acute, many roads put back into service open top wooden cars that would ordinarily have been retired and replaced with modern equipment. Since the price of cars has increased so greatly there seems to be a disposition to keep these cars in service. As a result it is a common thing to find wooden gondola cars under load with the sides bulging out so far that they are a menace to trainmen riding on the sides of other cars. In extreme cases, the side posts sometimes interfere with the safety appliances on cars on adjoining tracks.

There are several causes that lead to the excessive bulging of the sides of wooden cars. In many cases, the construction is such that the torsional strength of the side sills alone keeps the sides from spreading. If the underframe sags under the load, the distortion has a tendency to force the posts out still further. During recent years the increased difficulty of obtaining siding to extend the full length of the car has led to the use of short pieces, which further weakens the side.

Of the methods used to overcome spreading of the car sides the most common is the use of tie rods fastened to the tops of opposite posts. While this is a cheap and effective means of overcoming the trouble it should be used only as a temporary expedient, as the rods make the loading and unloading of long material very difficult. It is doubtful whether the bulging of sides can be entirely overcome on cars with weak underframes. Probably the most effective reinforcing for the sides on the majority of wooden cars is secured by adding diagonal tie straps to make the side act as a truss and by placing gusset sheets transversely in the center of the car to give lateral stiffness. If wooden gondolas are to be retained in service some effective method of strengthening the sides should be used.

Accidents Due to Locomotive Failures

Graphic comparisons of personal injury accidents resulting from failure of various locomotive details, classified by details and by years, included in an article appearing elsewhere in this issue, form a valuable summary of the work which has been done by the Division of Locomotive Inspection of the Interstate Commerce Commission during the seven years for which reports have been rendered, and throw into relief the points on which much improvement must still be made before a satisfactory situation can be said to have been reached.

One of the most striking comparisons brought out by the charts is the consistent and rapid decrease in the number of accidents due to boiler explosions from 1912 to 1915, followed by an almost equally rapid increase in the numbers of similar accidents in the years following, until a total of 90 was reached in 1918, only 7 less than the number reported in the fiscal year 1912. Considering the two principal classifications of causes of boiler explosions; that is, crown sheet failures due to low water, with and without contributing causes, it is significant that while the latter was reduced from a total of 69 accidents reported during the fiscal year 1912 to a minimum of 14 in 1913, and again increased to 38 in 1917 and 34 in 1918, the former had jumped from a minimum of 9 in 1915 to 51 in 1918, as compared with the largest number previously reported of 28 in 1913. The conditions reflected in these figures no doubt are due to the war, with the extraordinary demands for motive power which it created, and the unsatisfactory labor

situation both as to quantity and quality which the railroads had to contend with during the year 1918.

Post mortems, however, are of little value unless some lesson may be drawn from them for future guidance. In this case the lesson seems to be obvious. It is that any neglect of firebox maintenance, particularly of the inspection and maintenance of boiler appliances such as water gage glasses, gage cocks, injectors, steam gages, safety valves, etc., results in grave and immediate danger. Whatever slighting of work the exigencies of such a situation as that created by the war may seem to require, safety demands that this requirement be met elsewhere than in connection with the parts just mentioned.

While perhaps not among the leading causes of personal injury accidents, boiler studs are a persistent cause of a sufficient number of accidents to give weight to the author's suggestion that their use be eliminated in every way possible. Aside from the element of danger accompanying the use of the studs themselves the practice of hanging air pumps, sometimes two of the large 8½-in. cross compound compressors, on the shell of the boiler, with the vibrations set up by the pumps in operation, subjects the boiler shell to stresses in addition to those due to the working pressure the magnitude of which it is practically impossible to evaluate. While past experience offers nothing to occasion alarm on this point, the uncertainty as to the future results of the tendency toward increasing the severity of these secondary stresses, together with the trouble and occasional accidents due to the studs themselves, clearly justifies an effort on the part of the designer to relocate the various appliances and details now secured to the boiler with studs.

The suggestion of the author that the annual reports of the Division of Locomotive Inspection of the Interstate Commerce Commission be studied by all mechanical department foremen having to do with locomotive repairs, if followed, should have very beneficial results. A careful analysis not only of the countrywide results, but of the conditions on their own lines would result inevitably in a tightening up of maintenance at the weak points. A decrease in the number of accidents would follow, and fewer locomotives would be taken out of service by the Commerce Commission inspectors for needed repairs.

Modern High-Speed Steel

In a paper discussing the subject of high speed steel, appearing elsewhere in this issue, John A. Matthews makes the interesting statement that "it is still a constant source of surprise to see tests conducted in which a steel that may appear of inferior analysis proves successful, whereas some of the other type of analysis judged from this viewpoint only would naturally be expected to prove the better steel," and he draws the conclusion that "it, therefore, seems that steel-making rather than chemical analysis is the first consideration, and so far we are not able to define or to specify all the elements which enter in from the melting to the finishing of the bar to produce first-class material." These statements coming from a present day authority in steel making are the results of long experience in the manufacture and study of tool steels and the conclusions drawn should be given careful consideration by every one engaged in the production or use of high speed steels. It has generally been thought that the chemical analysis of steel bears a direct relation to its utility and efficiency and this is usually true, but it has been demonstrated, in exhaustive tests, that the chemical analysis of a high speed steel may be ideal, but if the tool making process is not properly conducted, the resulting tool will not be of a satisfactory quality. The heat treatment of high speed steel by the tool makers has a most important bearing on the quality of the cutting tool and must be carefully done. Very often too much reliance is placed on the chemical analysis and generally known good qualities of some particular brand of high speed steel with the result that a superior grade of steel often produces a very inferior tool because of the failure of the tool maker to realize the importance of his treatment of the metal. Conscientious work by the tool maker will add greatly to the serviceability of cutting tools and effect a substantial economy in tool costs.

The Ultimate Locomotive Stoker

One of the most difficult and vital operating mechanical problems which the railroad world must solve is that of the further development of the mechanical stoker for locomotives. What is the ultimate locomotive stoker to be? The urgent need of efficient and economical locomotive firing is clearly apparent when it is realized that from 80 to 90 per cent of the millions of tons of coal burned annually by the railroads of the United States is burned on the locomotive. This immense amount of fuel not only represents a vast money value as a commodity, but it is directly related to the problems of labor and transportation. Each ton of coal used needlessly or wastefully means the economic loss of the labor necessary to produce it, and is also an added burden to the already overtaxed transportation facilities of the nation. The physical limits of hand firing have been reached because of the great increase in the size of fireboxes on modern locomotives, and it has become necessary to devise mechanical means of conveying and distributing the fuel to the grate. Several types of mechanical stokers have been built and developed to a remarkable degree of efficiency, so far as supplying the fuel to the fire is concerned, but it is quite generally conceded by the stoker manufacturers that in the use of stokers fuel economy is largely sacrificed for increased capacity and that in fireboxes within the physical limitations of the fireman the stoker is not as economical as hand firing. The use of the stoker results in the production of more ton-miles per locomotive mile, which increases the efficiency and economy of operation, but it does not produce that result with as small a use of coal as is manifestly desirable.

The methods now in use for mechanically feeding fuel to the locomotive firebox may be divided into three classes: the class by which the fuel, after being crushed in comparatively small pieces, is conveyed to the door of the firebox and then blown on and distributed over the grates by means of steam jets; second, the class by which the fuel is crushed and conveyed to the firebox in a similar manner, but is distributed over the grates by purely mechanical means, and third, the class by which the fuel is pulverized before being placed on the locomotive tender and is blown into the firebox and burned in suspension.

While all of these methods have great advantages over hand-firing on large locomotives at present, and each of them has great possibilities of future development and may prove to be the much sought solution of the problem, it is at the same time quite conceivable that a method differing radically from those now in use will be devised and will solve better than any of them the problem of feeding into the locomotive sufficient quantities of fuel in such a manner as to secure as efficient or more efficient use of the fuel than can be obtained by hand-firing. That the manufacturers of mechanical stokers are alive to the situation is evidenced by their constant efforts toward improvement in their devices. The more extensively stokers of the present types are used on the railroads, and the more study railroad mechanical men as well as manufacturers give to the improvement of their design and operation, the more rapidly the results theoretically possible will be obtained in actual practice.

Advantages of Large Water Capacity for Tenders

One large western railroad has recently adopted the practice of equipping locomotives with tenders having a very large water capacity. The results secured have been so favorable that an analysis of the advantages and disadvantages of high water capacity will be of interest. The most evident benefit is the reduction of the number of water stops, which saves fuel and wear on the brake apparatus and reduces the running time, thus often effecting a saving in the wages of the train crew. Incidentally, the larger water capacity may permit of passing water tanks where the water is of inferior quality, or where the location makes starting difficult, which under certain conditions may be very important. Against these advantages must be balanced the increased tonnage hauled and the additional maintenance cost.

The amount by which the capacity must be increased to permit a reduction in the number of water stops varies under different conditions. With the usual spacing of water tanks an increase of 50 per cent will in most cases make it possible to run past one more tank between stops. In order to bring out the economies resulting from the elimination of the stop, assume a locomotive having a tender with a capacity of 8,000 gal. of water operating over a division 100 miles long on a run that necessitates taking water at five intermediate stops and coal at one point on the division. By increasing the water capacity to 12,000 gal. the number of water stops might be reduced from five to three and since a conservative estimate of the average cost of a stop is 60 cents, the saving per trip would be $1.20. As the extra weight of water would not increase the number of trains, the cost of hauling the increased weight would be limited to the cost of the additional fuel burned. The gross ton miles would be increased 833 ton-miles. Figuring the coal consumption at 250 lb. per 1,000 ton-miles and the cost at $3.50 a ton the extra fuel would cost 36 cents. Even though there is considerable increase in the cost of maintenance of the larger tender, there should be a substantial economy effected by its use.

Operating conditions will determine the extent to which the increase in water capacity can profitably be carried. In passenger service there would be no economy in providing capacity in excess of that required by the train between station stops where water tanks are located. For freight engines, however, the capacity could profitably be increased to the amount consumed between coaling stations where stops are necessary. This would require about twice the water capacity now usually provided.

The Shop Craft Strike

The scattering strikes of railway shop men, variously estimated at the time of going to press as involving from 100,000 to 250,000 of the approximately 450,000 men thus employed, and which will, if the threats of some of the leaders of the shop crafts unions are carried out, paralyze the transportation system of the country, seem to mark the breakdown of the policy followed by the Railroad Administration in dealing with the labor situation in the shops.

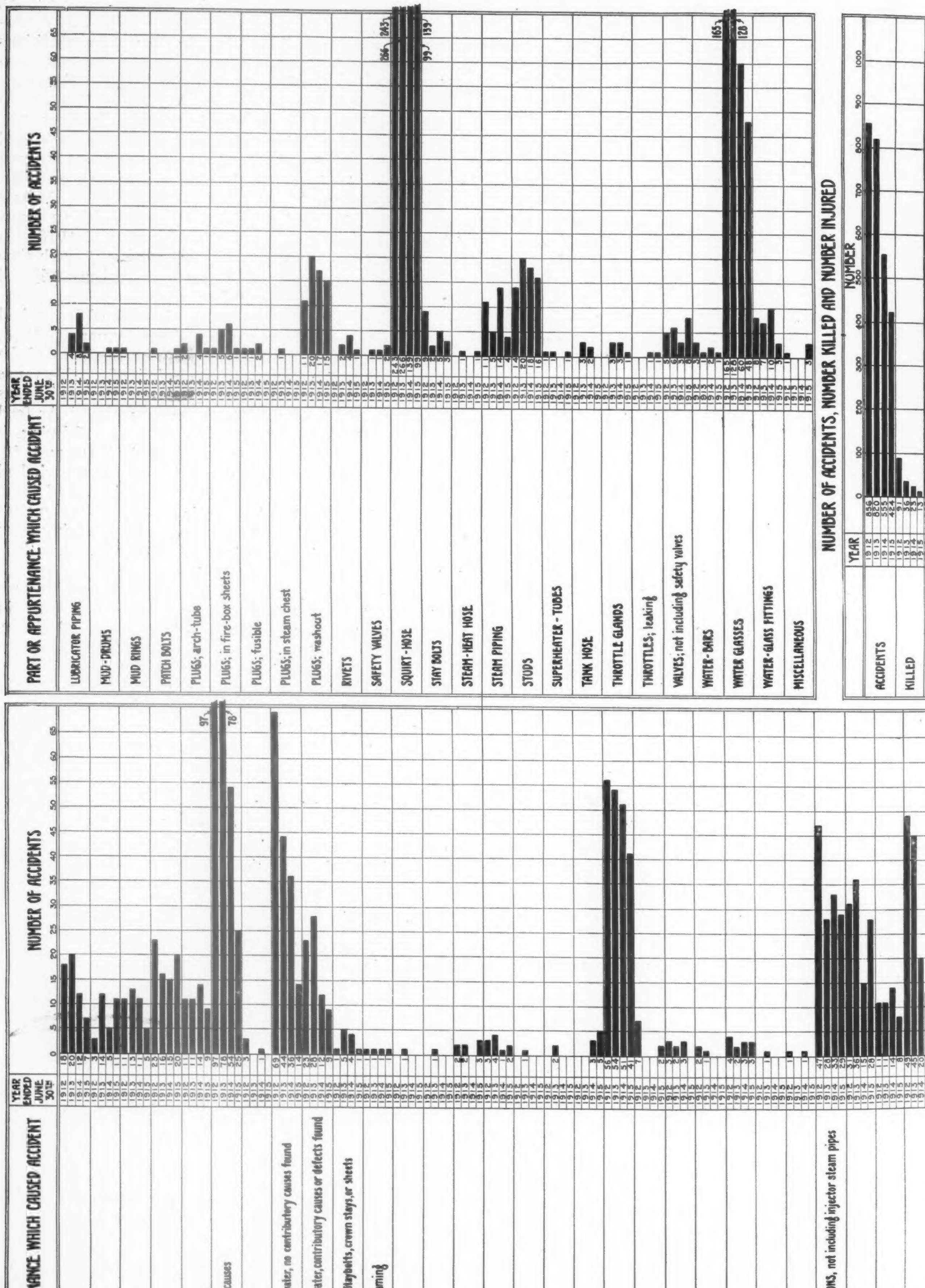
One of the early acts in the administration of Director General McAdoo was the creation of a railroad wage commission to investigate and recommend adjustments and increases required to meet the special conditions created by the war. During the latter part of 1915 and early in 1916, conditions at which time were assumed by the wage commission as the basis of its work, railway mechanics were receiving from 34 to 38 cents an hour, with earnings ranging approximately from $75 to $90 a month. During the intervening two years, however, increases had been given by the railroad companies, so that the average monthly earnings of mechanics for 1916 had ranged from $90 to over $100, and for 1917, from $105 to about $120. The award proposed by the wage commission, based as it was on conditions as of December, 1915, was modified by the Director General in General Order No. 27 in order that the shop men might receive some increase and a minimum of 55 cents an hour was established for mechanics. This, however, met with immediate expressions of dissatisfaction, accompanied by a number of local strikes, and was followed by a request for an increase in the mechanics' rate to 75 cents an hour. In July, Supplement No. 4 to General Order No. 27 was issued, raising the mechanics' rates to 68 cents an hour, which rate was to be retroactive to January 1, 1918. It also authorized the eight-hour day after August 1, with time and a half for overtime. Incidentally, Supplement No. 4 resulted in the destruction of piece work.

According to the wage commission the cost of living had increased by from 37 to 40 per cent from January 1, 1916, to January 1, 1918. The Bureau of Labor Statistics of the Department of Labor quotes average prices of a wide range of food products, the average increase in price of which was 16 per cent from January, 1918, to January, 1919. As food is the largest single item entering into the cost of living, it hardly seems possible that the cost of living in January, 1919, or about the time the present demands were presented, had advanced more than 60 per cent since the beginning of 1916, although the labor leaders base their present wage demands on an alleged increase of some 80 per cent. Judging from the month to month increases in food prices since that time, it is impossible to conceive that a 100 per cent increase has taken place up to date. But the wage rates of the shop men have increased approximately 100 per cent over those in effect late in 1915. The increase in the cost of living, therefore, seems clearly to be a specious and fallacious argument in connection with the present wage demands.

The source of dissatisfaction is not merely the increase in living costs. The spread of labor union policies, which it was supposed would cause satisfaction, probably is responsible for much of the dissatisfaction. Take the piece-work situation: Men who had been averaging good earnings on a piece-work basis before the issuance of Supplement No. 4, found themselves under the provisions of this order, earning practically as much as before without any effort on their part, and what was worse, with their hands tied so far as their ability to further increase their earnings by their own efforts was concerned. A source of dissatisfaction and unrest among piece workers was thus created. Another provision of Supplement No. 4 was the institution of the eight-hour day with time and a half for overtime after August 1, 1918. This resulted in a temporary increase in earnings, a reduction in which soon followed when overtime work was discontinued. A reduction of earnings is never a source of satisfaction and good feeling.

The failure of the liberal policy of the Railroad Administration in its dealings with labor to meet with a response in the way of stimulated effort or co-operation is generally conceded and has been commented on in some of its phases in these columns. The following case is typical in kind, if not strictly in degree, of a general condition: A certain engine terminal in eastern territory, which in 1916 despatched 100 engines daily in addition to taking care of some heavy Mallet repairs, employed about 200 men in two shifts. Since the first of this year the same terminal has employed over 500 men in three shifts. From $15,000 to $16,000, the payroll has increased to $130,000 a month in the same period.

Just what will be the outcome of the present situation no one can predict. It is, however, quite evident that no satisfactory and stable working arrangement can be effected until the worker and the manager in their relations with one another are free to and do give expression in what they say and what they do to their own inherent sense of justice.



Compiled from the Annual Reports of the Chief Inspector of Locomotive Boilers to the Interstate Commerce Commission

Fig. 1—Personal Injury Accidents Resulting from Failures of Locomotive Boilers and Their Appurtenances—1912 to 1915 Inclusive

Injuries from Locomotive Failures

Suggestions for Their Reduction Based on a Digest of the I. C. C. Locomotive Inspection Reports

BY JOHN L. MOHUN
Assistant to Consulting Fngineer, Union Pacific System

By presenting the personal injury accidents, as listed in the several annual reports of the Chief Inspector of Locomotive Boilers to the Interstate Commerce Commission in a comparative graphic form, with an analysis of the cause of the principal locomotive failures which caused these accidents, it seems possible that means may be devised whereby accidents due to such failures may further be reduced.

As these reports emanate from a source independent of the railroads and are national in scope, tendencies toward faulty construction or improper maintenance are naturally more forcibly brought out than in the case of the usual railroad mechanical department reports covering locomotive failures, which are confined to a single or a system of roads. Therefore, serious attention should be given these reports and the recommendations as to improvements made by the Chief Inspector.

The Federal Locomotive Boiler Inspection Law enacted February 17, 1911, made it unlawful to operate a locomotive with its boiler in an unsafe condition and prescribed rules and regulations for the inspection and test of the boiler. The law further requires the railroads to report to the Interstate Commerce Commission all accidents resulting from locomotive boiler failures or their appurtenances causing serious personal injury or death. The Commission considers a serious injury as one causing the person involved to be incapacitated for more than three days in the aggregate within ten days immediately following the accident. The law also requires the facts concerning such accidents to be investigated by the Chief Inspector of Locomotive Boilers or one of his assistants.

The Congress on March 4, 1915, amended the original Locomotive Boiler Inspection Law by making its provisions apply to the entire locomotive and its tender and all their appurtenances. The features as to reporting and investigating accidents remain the same.

Attention is invited to the charts, which present the personal injury accidents in a comparative graphic form for the years 1912 to 1918 inclusive. As the law at first related solely to the locomotive boiler, Fig. 1 lists the personal injury accidents chargeable to the failure of locomotive boilers and their appurtenances only, for the years 1912 to 1915. As the law was later amended to cover the locomotive and its tender, Fig. 2 covers all personal injury accidents chargeable to the entire locomotive and tender, and their appurtenances, for the years 1916 to 1918 inclusive.

It is obvious that certain tendencies indicated by these charts must be interpreted with reservations, as there are a number of conditions varying from time to time which should be given consideration before drawing definite conclusions, such as the amount of traffic, number of locomotives in service, weather and labor conditions, and the very abnormal state of affairs brought about by the world war in the past few years. However, these charts and the information given in detail, covering individual accidents in the annual reports of the Chief Inspector, bring out certain features in such a pronounced manner that quite definite conclusions can be drawn notwithstanding the effect of these variable conditions.

The predominating feature in Fig. 1 is the consistent reduction each year in the total number of accidents, number killed, and number injured. In the majority of cases this is also true of the number of accidents chargeable to the failure of individual parts of the boiler or its appurtenances. Evidently the material falling off in traffic during the years 1912 to 1915 had considerable to do with reducing the number of accidents, but undoubtedly a large amount of this improvement was directly attributable to the rules and regulations governing the inspection and testing of locomotive boilers and their appurtenances, put into effect in 1911 and 1912 by the Division of Locomotive Boiler Inspection of the Interstate Commerce Commission, and the general co-operation of the railroads, locomotive builders and the railway supply companies.

Fig. 2 shows a reverse state of affairs, with the exception of the number killed, in this respect 1918 showing an improvement over 1917.

The increased number of accidents between the years 1915 and 1916 was primarily due to the extension of the law to include the entire locomotive and tender; and the increase each year from 1916 to 1918 no doubt was principally caused by the abnormal condition the railroads were working under during these years, resulting from the war and the severe winter of 1917-1918. It is obvious that even if conditions had been normal during these years the same ratio of reduction in accidents which occurred in the first few years after the Locomotive Boiler Inspection Act went into effect, could hardly have been expected.

The principal accidents causing personal injuries shown by these charts were due to the failure of the following locomotive parts or their appurtenances: Boilers, flues, grate shakers, injector and connections, injector steam pipes, reverse levers, squirt hose, lubricator glasses, water glasses.

BOILERS AND THEIR APPURTENANCES

Of these items, boiler failures are, of course, the most serious, both in the loss of life and damage to property. Fig. 1 shows a large reduction in the number of boiler explosions from all causes, there being 97 in 1912 as compared with 25 in 1915. Fig. 2 shows just the reverse, there being an increase in the number of boiler explosions from all causes from 41 in 1916 to 90 in 1918.

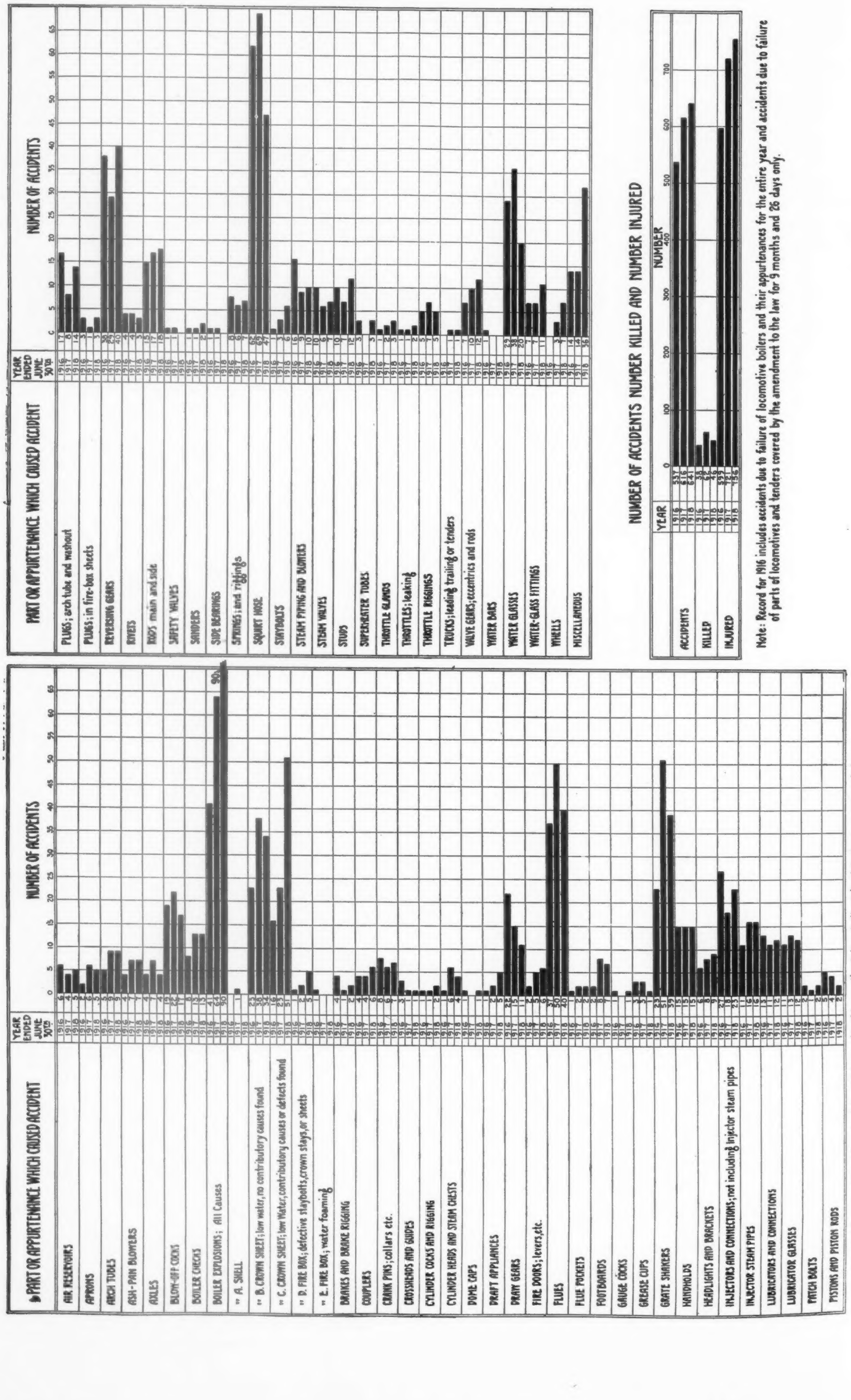
As will be seen by these charts, boiler explosions due to low water, no contributory cause, fell off fairly constantly from 69 in 1912 to 34 in 1918; but explosions due to low water, contributory causes or defects found, increased during the same period from 23 to 51.

The following cases of contributory causes to boiler explosions are taken from the Chief Inspector's reports for the years 1912 to 1918, and a considerable percentage of all boiler explosions disclose similar self-evident defects.

"A bad leak was found in packing nut of top water glass cock; no packing in nut at all, and valve handle was wired to prevent it from being blown out. Union nut in steam pipe to water glass was very loose and had been leaking badly. Such leaks cause water to raise in the glass and show an incorrect water level. These leaks had been reported four times previous to accident."

"Improperly located water glass and gage cocks; lowest reading of water glass one-eighth inch above highest point of crown sheet; bottom gage cock $1\frac{1}{8}$ inches above highest point of crown sheet; locomotive received new fire box nine months before accident and had evidently been operating in this dangerous condition for that length of time."

"Obstruction in bottom water glass fitting; bottom gage cock stopped up with solid scale and inoperative and water glass cocks and three gage cocks not extending through reinforcing plates."



Compiled from the Annual Reports of the Chief Inspector of Locomotive Boilers to the Interstate Commerce Commission

Fig. 2—Personal Injury Accidents Resulting from Failures of Locomotives and Tenders and their Appurtenances—1916 to 1918 Inclusive

"Both injectors defective; injectors reported 14 times previous to accident."

"The failure occurred along the edge of the longitudinal seam where a crack had formed completely through the plate in several places and more than halfway through for the entire length of the course. The engineer had reported a leak under the jacket at this point three times immediately prior to the accident."

"Crown bolt heads defective and excessively calked, due to having been overheated some time previous."

"Crown sheet failure, overheated; water foaming badly; reported six times by different engineers prior to accident, but boiler not washed."

"Twelve crown bar braces were defective on account of seven pins missing; four pins broken and one brace broken. Scale was found in the crowfoot holes, where pins should have been, showing that pins had been out for some time."

"Mud ring cracked and leaking badly; reported 18 times, and crown bolts reported leaking badly 16 times within 30 days prior to the accident."

"Opening in fusible plug filled with sediment or slag, rendering it inoperative; report of inspection made three days before accident occurred, shows fusible plug removed and cleaned, yet it was found in this condition and had to be cut out of the sheet."

It is realized that quite often locomotive running repairs have to be made from day to day, under the most trying circumstances as to constant demand for and shortage of power, lack of proper facilities, and other unfavorable conditions. These facts should not, however, be considered valid reasons for placing locomotives in service without knowing that such serious defects as those listed above do not exist.

BOILER STUDS

The charts show a yearly average of about fourteen personal injury accidents chargeable to the failure of boiler studs, but the Chief Inspector's reports disclose many times this number found by the district inspectors in a leaky or defective condition. A large number of accidents are shown to be due to studs blowing out on account of improper application, in some cases not more than two or three threads having entered the sheet. A number of accidents were also caused by studs failing, while being tightened, under pressure. The Chief Inspector in his sixth annual report states that studs should not be repaired by calking and under no circumstances should an attempt be made to tighten them while there is steam pressure on the boiler.

An effort should be made to reduce as much as possible the large number of studs now being placed in the boiler for attaching various parts and auxiliary devices, especially when the device produces vibrations or shocks on the studs, such as is the case with air compressors and reverse lever quadrants.

In connection with large Mallet locomotives, several railroads and the Railroad Administration have placed the air compressors on the front of the locomotive and it is believed that this should be followed generally with respect to all large locomotives for the reasons that all boiler studs are dispensed with, the compressors can more readily be looked after by the engine crew when running and as two compressors are usually used on large locomotives, by placing one on each side of the center line an equal weight distribution is obtained. By placing the compressors on the front, instead of on one side of the locomotive, more free air would be passed over the air cylinders when running, thus securing a better cooling effect.

The reports show a number of failures of studs which attach the reverse lever quadrant, undoubtedly due to vibration set up in the reach rod. The use of a power reverse gear wherein the shocks or vibrations are cushioned by the air in the cylinder, would seem to offer means for avoiding this trouble.

There are also a number of minor parts fastened to the boiler by studs which by a little study on the part of the designer, could be avoided; for example, usually two steps are provided in connection with the sand box, requiring altogether four boiler studs. A light ladder could readily be substituted; secured at the top to the base of the sand box, and at the bottom to the running board.

On all of the locomotives recently ordered by the Railroad Administration, with the exception of the switchers, the bell stand is attached to the front end. This is good practice, as it is not only the logical place for the bell, but all boiler studs for attaching the stand are dispensed with. Such matters as the fastening of sand box steps and bell bases may seem of little moment, but there are many such parts which may be similarly treated to eliminate boiler studs, which taken in the aggregate assume considerable importance.

When a new firebox, back end or an entire boiler is applied to an old locomotive it is generally renewed in kind, with the possible exception of the application of a superheater and a brick arch, and certain improved features of construction developed in the past few years are not usually employed, although such improvements may cost little or nothing. In renewals of this kind where boilers have originally been attached to the frame by means of pads and clamps in connection with which a large number of studs are placed in the firebox sheets, it would seem advisable to substitute furnace bearers or furnace expansion plates attached to the mud ring of the firebox, thus dispensing with the troublesome boiler studs. If the side grate bearers had originally been supported by studs placed in the side sheets of the furnace, it would also seem desirable when renewing a firebox or back end to substitute the more modern method of supporting the grate bearers; that is, by brackets fastened by studs placed in the mud ring, thus further dispensing with boiler studs.

When a firebox, back end or a new boiler is installed, the steam turret and possibly the injectors could be placed outside the cab; thereby reducing the possibility of accidents due to the failure of their steam connections.

BOILER WASHOUT PLUGS

These reports show that quite a number of accidents are caused by boiler washout plugs being tightened while under pressure. After a boiler has been washed, filled with water and fired up, if a washout plug should be found leaking it is a very natural temptation, in order to save time and labor, to attempt to tighten the plug while under pressure. But the very fact that the plug is leaking indicates that the fine threads may have been crossed and it should in no case be touched with a wrench while the boiler is under pressure.

ARCH TUBES

The charts indicate a yearly average of about 11 accidents caused by the failure of arch tubes. The reports show the major number of failures due either to an accumulation of mud within the tubes or faulty setting. In 1912 there were 18, and in 1918 only 9 accidents chargeable to arch tubes. Considering the fact that the number of arch tubes in service increased in this period from approximately 40,000 to 100,000, the showing may be considered a very satisfactory one and indicates that those concerned realize the importance of keeping arch tubes free from obstructions in order to obtain proper circulation through the tubes and thereby prevent them from being burnt.

TUBES

By referring to the charts it will be noted that personal injury accidents due to the failure of tubes fell off quite consistently from 56 in 1912 to 40 in 1918, most of the failures being due to poor welds; but the reports show a much greater improvement in the number of defective or leaky tubes found by the district inspectors, the decrease being about from 2,270 in 1912 to 565 in 1918. Unquestionably this improvement was largely due to better methods of setting tubes, electric welding of beads, and the rule of the Commission limiting the use of tube plugs and specifying, when they are used, they must be tied together with a rod through the tubes.

SUPERHEATER FLUES

Only nine accidents are shown by the charts for the years 1912 to 1918 due to the failure of superheater flues, which

indicates that these flues are being well maintained, especially when it is considered that the total number of superheater tubes in service increased from about 125,000 in 1912 to 980,000 in 1918.

AUTOMATIC FIRE DOORS

In order to reduce as much as possible the serious consequences of firebox, flue, and arch tube failures, the Chief Inspector in his annual report for the year ended June 30, 1917, recommends that all new and all locomotives then in service, when receiving general repairs, be provided with a mechanically operated fire door, so constructed that it is only open when the operator places his foot on the pedal. He further states that with the ordinary swing door, such boiler failures invariably result in blowing the fire door open and discharging steam and boiling water, together with the contents of the firebox, into the cab of the locomotive, seriously or fatally burning persons therein. He also directs attention to the fact that with the automatic fire door, the door will remain closed if the failure occurs while it is closed; and if the failure takes place while it is open, it will automatically close the instant the fireman's foot is removed from the operating device, thus preventing the direct discharge of steam and scalding water into the cab of the locomotive.

From the above it would appear that the automatic fire door is a most important safety device, and its use is well warranted solely for this reason and regardless of its coal saving features, which are generally recognized.

GRATE SHAKERS

As disclosed by Fig. 2, personal injury accidents chargeable to grate shakers amounted to 23 in 1916; 51 in 1917 and 39 in 1918. Reports show these accidents principally due to improper maintenance of the grate shaker mechanism, such as worn or missing pins and hand shaker bars slipping off staff, due to wear in the socket and the lever stub. The use of steam operated grate shakers should preclude the possibility of such accidents.

As a large number of grate bars on old locomotives are connected by single rods placed on one side of the lug on the grate bars and employ rather small pins, lost motion is soon set up and the whole grate shaker mechanism becomes loose and wobbly and when in this condition is liable to cause an accident.

It would appear advisable in such cases to substitute a more modern method consisting of double connecting rods, one placed on each side of the grate bar lugs with large, substantial pins. This change could be made at a relatively small cost. If it should require a change in, or relocating of, the lugs on the grate bars, this could readily be taken care of at practically no increase in cost, as grate bars have to be renewed constantly. At the same time it might be found expedient to redesign the grates in order to conform to more modern practice, especially as to providing maximum air openings obtainable without the loss of coal, thereby increasing the coal burning efficiency of the grates. This can be done at small cost due as stated before, to the fact that grates have to be replaced repeatedly.

As coal dust frequently accumulates on the top of the grate lever stubs, the socket of the detachable hand bar should be so arranged that there would be at least one inch clear space between the bottom of the socket and the top of the stub lever when the socket is placed home on the stub. Further, a hole should be drilled through the sides and at the bottom of the socket in order to allow any coal which may have lodged on the top of the lever to fall out.

INJECTOR AND CONNECTIONS

The charts show that personal injury accidents chargeable to the failure of injectors and connections (not including injector steam pipes) decreased almost constantly from 47 in 1912 to 23 in 1918, and accidents chargeable to injector steam pipes fell off in the same period from 31 to 16. The reports indicate that practically all of these accidents were due to the union nuts or brazed on collars. Failure of union nuts were due in most cases to threads stripping, nuts too large or broken by the use of improper tools, such as hammer and chisel. A large number of accidents are shown to be due to the failure of union nuts while being tightened under pressure. This is, needless to say, a dangerous undertaking and should be avoided. Failure of the brazed collars and sleeves is generally due to poor brazing. The district inspectors' reports disclose the fact that there were 26,342 injectors and connections found defective in 1913 and that there was practically a consistent reduction to 5,803 in 1918. Even the latter figure seems to indicate a rather bad state of affairs as to the proper maintaining of so important a piece of apparatus, especially in view of the Commission rule requiring the injectors to be tested before each trip.

Undoubtedly the use of non-lift injectors placed outside of the cab, and the so-called "mechanical" pipe joints in place of brazed collars, both of which are now coming into general use, will materially improve conditions in this respect.

REVERSE LEVERS

Fig. 2 shows that there were 38 accidents in 1916, 29 in 1917 and 40 in 1918 chargeable to the failure of reverse levers.

District inspectors' reports disclose that there were 60 defective levers found in 1916, 178 in 1917 and 244 in 1918. Practically all of these accidents are shown to be due to the reverse lever slipping out of the quadrant, caused by the worn condition of teeth of the quadrant or lever latch, defective latch springs or dirt in quadrant. On account of the incessant vibrations which the valve motion sets up in the reach rod it is very difficult to keep lost motion out of the teeth of the quadrant and reverse lever latch. The writer believes that the most practical way to reduce accidents of this kind is by the use of a power reverse gear in which the vibrations in the reach rod are cushioned and absorbed by the compressed air within the reversing cylinder.

SQUIRT HOSE

There were 266 personal injury accidents in 1913 due to squirt hose. The number has quite consistently been reduced to 47 in 1918. District inspectors' reports show 3,711 squirt hose or applications found defective in 1913, which was consistently reduced to 511 in 1918. Practically all of these accidents are shown to be due to the squirt hose blowing off, parting at splice or bursting caused by defective hose or clamps. These accidents usually resulted in scalding the fireman, as until recently the water for the squirt was generally taken from the delivery pipe of the injector. Undoubtedly the very satisfactory improvement made in the number of accidents chargeable to this device is due to the fact that the attention of all concerned was focused on the large number of accidents caused by such an insignificant piece of apparatus, with the result that a one piece hose of better quality, sometimes armored, was used and more substantial clamps and attachments generally provided. A considerable amount of credit for this improvement is also due the several injector manufacturers who have developed squirt hose attachments which deliver water cool enough to be handled without danger.

One of the large eastern railway systems uses a cold water sprinkler or squirt arrangement, consisting of a small reservoir of about ten gallons capacity, placed inside and at the bottom of the tender tank. The reservoir is provided with a strainer and check valve through which water is admitted from the tank of the tender, the sprinkler hose connection

being taken from the bottom of the reservoir. Air from the main reservoir is admitted to the top of the small water reservoir through a hand operated valve located at a convenient place on the tender. When the air pressure is turned on the check valve closes and cold water is forced from the reservoir through the sprinkler hose. When the air pressure is released the reservoir is automatically recharged with water through the check valve.

LUBRICATOR AND WATER GAGE GLASSES

Accidents chargeable to the failure or breaking of lubricator glasses fell off quite consistently from 49 in 1912 to 12 in 1918, and those due to the failure of water gage glasses from 165 in 1912 to 20 in 1918. The decided improvement between the years 1912 and 1918 must be largely attributed to the Commission's rule requiring all tubular water and lubricator glasses to be provided with a suitable shield, although the reports indicate that there are still occurring a number of accidents chargeable to inefficient shields. The more general use of the "bulls-eye" type of lubricators and the "reflex" type of water gage also probably contributed to this improvement; however, the reports show that the glasses in these two devices are also failing and causing accidents.

AIR RESERVOIRS

Fig. 2 indicates that there were from four to six accidents each year chargeable to the failure of air reservoirs generally caused by corrosion through the underside of reservoir. In at least one case the material had wasted away until only 1/64 in. remained at the time of bursting. Possibly these reservoirs were old and had not been enameled and baked inside and out, as has been the practice of the air brake companies for the past several years. However, it would seem that if these reservoirs had received the proper hydrostatic and hammer tests, as prescribed by the rules, the thin sheets would have been detected and the accidents avoided.

BLOW-OFF COCKS

The number of accidents chargeable to the failure of blow-off cocks is shown to have been from 15 to 20 each year since 1912 and to have been due to defective threads, cocks, or their operating mechanism. This would seem to indicate that these parts are not being maintained as well as their importance requires. As the cocks which are now generally being used are of an improved type and of more substantial construction than those formerly used, an improvement in this respect may be looked for in the future.

DRAW GEARS

Personal injury accidents due to the failure of draw gears fell off from 22 in 1916 to 11 in 1918—probably the result of the rigid rules of the Commission governing the proper maintenance of draw gears. These accidents are generally shown to have been due to the pins or holes in the bar being worn, or to flaws or defects in the materials of which they are made. A number of these accidents are also reported as due to excessive lost motion between locomotive and tender and in several cases the safety chains are stated as having been too long. When one of the pins or the drawbar breaks, the entire shock due to the momentum of the locomotive is taken by the safety chains or safety bars, and on account of the slack which it is necessary to provide in these parts, they generally fail to hold the locomotive and tender together. Naturally the results of such accidents are usually of a serious nature. The type of gear whereby a single heavy safety bar is placed directly under the drawbar and on the center line of the locomotive, thus requiring a very small amount of slack, would seem to offer means whereby accidents of this kind could practically be avoided.

GENERAL CONCLUSIONS

The writer is unable to say to what extent the annual reports of the Chief Inspector are in the hands of mechanical department employees, but all such employees as general foremen of locomotive department, roundhouse foremen, foremen boilermakers and their subforemen should be supplied with them as issued, for the reason that they not only list and classify all accidents, but the cause and circumstances under which they occur are clearly stated. They should also be of considerable value to the several locomotive builders and to all companies furnishing locomotive appliances.

The intelligent interpretation of the causes of these accidents should not only reduce their number, but it should also tend to improve the efficiency of the men and equipment, which is of the utmost importance at the present time on account of the prevailing high cost of labor and material.

The Chief Inspector's reports reveal the fact that personal injury accidents, due to the failure of certain locomotive parts, are occurring to a much greater extent on some roads than on others in proportion to the number of locomotives operated by each road and allowing for other varying conditions. This prompts the suggestion that the mechanical department of each railroad check the design, material and maintenance methods of all parts which are shown by these reports to be causing them an excessive number of failures, with the design and maintenance practice of similar parts showing the best performance on locomotives of other roads operating under approximately the same conditions.

When the Congress passed the original Boiler Inspection Law in 1911 it was thought unnecessary by a number of railroad men, and resented by some as an unwarranted interference with their prerogatives, but largely due to the practical manner in which the provisions of the law have been administered by the Division of Locomotive Boiler Inspection under the Interstate Commerce Commission, its beneficial results are now fully recognized and railroad men generally are heartily co-operating with the Commission.

The writer, having had actual roundhouse experience, fully realizes that it is a very simple matter to analyze locomotive accidents and to offer suggestions for their avoidance in the future, in comparison with the very difficult problem of actually maintaining running repairs in a thoroughly practical manner under the quite common conditions of shortage of power and inadequate facilities. He therefore trusts that any criticisms made in this article will be understood in this light, and as having been offered solely as constructive criticism for the possible betterment of the future service.

STANDARDIZATION IN FRANCE AND BELGIUM

BY ROBERT E. THAYER

European Editor

Equipment standardization in France and Belgium is being considered principally for the reason that large quantities of new equipment must be built eventually and vast quantities must be repaired because of the great amount of damage done to the cars and locomotives in both countries by the Germans during the war, and also because of the fact that the maintenance of equipment in both these countries had to be seriously neglected.

Four of the important French railways, namely, the Paris-Lyons-Mediterranean, the Paris-Orleans, the Midi, and the State railways, have formed a committee for the consideration of standard equipment. Two designs of locomotives are being considered, one of the Pacific type for passenger service, which will have driving wheels of about 78 in. in diameter, and a Mikado locomotive for fast freight and heavy grade passenger service, having driving wheels of about 65 in. in diameter. It is very interesting to note

that these locomotives will be of the two cylinder, simple, superheater type. With the improvements in the design of this type of locomotive, it is now generally conceded in France that the economies obtained from the compound locomotives as compared with a good design of two cylinder, simple locomotive using superheated steam, do not warrant the increased first cost, the increase in the cost of maintenance and the added complication of the compound locomotives. Furthermore these standard engines will have a lower factor of adhesion than is customarily used in America. The design will probably not give a factor any higher than 3.5.

The traffic conditions in France are such that a high speed locomotive is needed both in passenger and freight service. The Pacifics will be designed to operate at a speed of about 74 m.p.h. and to work on grades of 0.5 and 0.6 per cent. The Mikado locomotives are to be built for speeds of about 56 m.p.h. and for grades of from one to 1.2 per cent. The axle load of these locomotives will be limited to about 41,000 lb. as that is the limit required by the Minister of Public Works and Transports of France. This limit is set on account of the fact that many of the bridges in France are too weak to carry a higher wheel load, and as a general rule there are two less ties used per rail than is the practice in America.

The adoption of the two standard types of locomotives does not mean, however, that other locomotives will not be built, and it is expected that other locomotives will be designed and built by any of the four roads to meet any special conditions they may have. However, as many details as possible will be the same as those used on locomotives built to the standard designs.

There are five standard designs of cars to be built; two types of box cars, with and without screw brakes; two types of coal cars, with and without screw brakes, and flat cars with no screw brakes. The question of power brakes is under consideration. It is the desire of progressive engineers in France to have continuously braked freight trains, but whether this will be permitted with the excessive amount of slack between the cars of the present day French freight train with the type of coupling in use at present, remains to be seen.

Several engineers have expressed a strong desire to use automatic couplers, but with the present screw type of coupler generally used in France, the introduction of the automatic coupler would entail numerous difficulties, and until some design of automatic coupler is made which will readily interchange with the screw type of coupling now used, but little will be done in this respect.

The work on standard passenger cars has not progressed to the same extent as in the freight cars. They will, however, be of all-steel construction. This type of construction is not new to French railways. The Paris-Orleans has built nothing but steel passenger equipment for years, and, in fact, some of our first steel equipment was patterned after the Paris-Orleans designs.

The work in Belgium has not developed to the extent that it has in France, but the conditions in Belgium are such that until the disposition of the German equipment running on Belgian rails under the terms of the Armistice is known, no definite plans will be formulated. The Belgians, in addition to their varied stock of power, have had to cope with the added inconvenience of some 40 to 45 designs of German locomotives and innumerable designs of German cars. This has accentuated the need of equipment of more uniform design. It is the desire of the State railways there eventually to return the German equipment and receive indemnities with which to buy new equipment. If this is granted—it is doubtful if it will be—some plan of standardization will be formulated as a vast amount of equipment will have to be built to replace the equipment which has been destroyed during the war.

EQUATED TONNAGE AND FUEL CONSUMPTION *

BY R. N. BEGIEN
Federal Manager, Baltimore & Ohio, Western Lines

Equated tonnage has a certain relation to fuel consumption. However, this relation is established through the medium of the trainload. The fuel consumption per gross ton mile decreases as the trainload increases, provided the speed of the movement does not suffer to such an extent as to increase the time on the road materially. The purpose of equated tonnage is to secure uniform loading of power, regardless of the kind of equipment or number of cars involved. It is a well known fact that an empty car has a much higher resistance per ton of weight than a loaded car. For example, a 20-ton empty will show a resistance in the neighborhood of eight pounds per ton of weight, or 160 lb. total resistance to traction on a level. On the other hand a 70-ton car shows a resistance of approximately four pounds per ton of weight, or 280 lb. of resistance to traction on a level. These figures are approximate, but for practical use are correct. Of course many other features enter into the question, such as temperature, wind, rate of grade, curvature, type of car, etc.

In order to make practical standards which can be placed in the hands of yardmasters, it is necessary to use certain adjustments in building up trains, and to modify them as is necessary in the judgment of the chief train despatcher to suit conditions under which the operation is conducted. If a locomotive is able to produce 30,000 lb. of effective tractive effort behind the tender at rating speed, the train should have a combined resistance of 30,000 lb., irrespective of the character of the cars, and in order to accomplish this a certain arbitrary adjustment is added to the weight of each car, and the effect of this arbitrary adjustment is to automatically compensate the different weights of cars. This adjustment varies with the rate of grade, being about 15 tons per car on a 0.3 per cent grade, and about two tons per car on a 2½ per cent grade.

Building up a train tonnage, composed of the dead weights of cars, plus an adjustment, so that the combined resistance of the cars is equal to the effective tractive power behind the tender, gives a tonnage which is known as an equated tonnage. The object is to secure uniformity of rating in order that the trains will always have a rated tonnage, irrespective of the kind of cars. There are a number of different ways of applying this principle, but unless some kind of equated tonnage is used it is not possible to rate trains with any degree of accuracy.

It is safe to say that any road which has not used the equated tonnage system, and which has through freight to haul, has not built up its trainload to the best possible advantage. Full trainload at uniform speed spells efficiency in fuel consumption, and the relation of equated tonnage to fuel consumption is very clearly evidenced through the trainload.

Proper train loading contemplates each locomotive handling the maximum trainload which it can move on the ruling grade at the economic speed. At such speed the locomotive is working most efficiently. An increased speed, which may be brought about by reduced trainload, will result in inefficient locomotive performance, while a reduced speed, brought about by overloading, will produce the same result. With all trains moving at the economic speed, the locomotives operating at maximum effort and hauling the uniform trains under these conditions, the fuel consumption, when measured on the ton-mileage basis, will be the minimum obtainable.

*Abstract of paper presented before the International Railway Fuel Association convention at Chicago, May 19-22, 1819.

Mechanical Stoking of Locomotives*

Factors Determining Necessity of Applying Stokers; Operating Results Secured by Stoker Firing

BY W. S. BARTHOLOMEW
President, Locomotive Stoker Company

THE FIRING OF MODERN LOCOMOTIVES by mechanical means could properly be separated into four distinct subjects: First, the stokers themselves; second, the locomotives to which they are applied; third, the particular reasons which lead up to any given application, and fourth, the results which were achieved by such application. I assume that you are familiar with all of the stokers which are now being applied to locomotives and shall begin with the second subject.

All locomotives do not require stokers. Locomotives that can be hand-fired to maximum capacity through sustained periods do not require stokers. Locomotives which are of such size as to come within the specifications of those which are regularly being equipped with stokers, but which are not operated beyond the limits of hand-firing, do not need stokers. These statements must lead to the conclusion that only locomotives which are of such size as to bring them regularly beyond the limits of hand-firing, or locomotives of smaller size but which are regularly operated beyond the limits of hand-firing, require stokers. This must mean that we do not need stokers to do a hand-firing job and that the stoker job cannot be done by hand. This means also that stoker-firing and hand-firing are not directly comparable. Up to the present time, no locomotives have been equipped with stokers which do not need them.

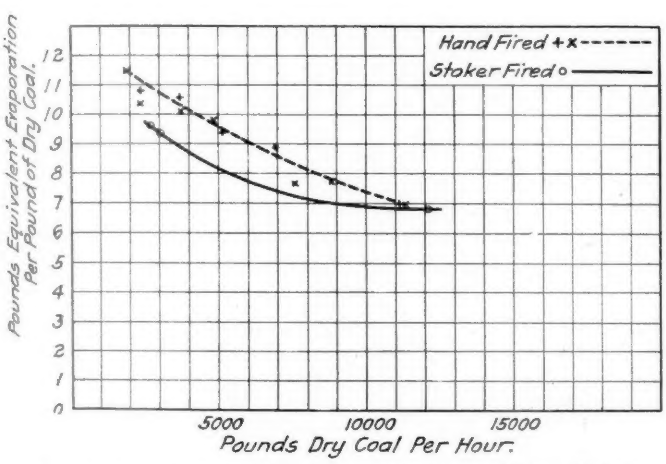


Fig. 1—Comparative Evaporation, Hand and Stoker Firing

LOCOMOTIVES WHICH REQUIRE STOKERS

These statements must bring up immediately the question as to whether such a definite line can be drawn between locomotives which do not need stokers and those to which they could be applied to advantage. To show you that a definite line can be drawn as to locomotives which can be hand-fired through sustained periods and those which cannot, my own convictions are that no locomotive really requires a stoker that does not weigh approximately 200,000 lb. on drivers, have a calculated tractive power of 50,000 lb. or over, a grate area of 60 sq. ft. or over, and a coal consumption through sustained periods of 4,000 lb. or more per hour.

The commercial application of Mechanical Stokers to locomotives really began in 1910. One of the first important stoker applications was made to five very large locomotives which were designed and built originally to be equipped with stokers. This is especially significant in that, in the main practically all stoker applications have been made to date to locomotives without requiring any general modification in the conventional locomotive design. This application was made on a Chicago, Burlington & Quincy M-2 Santa Fe type locomotive which included in its original specifications such details of design as would permit the application of the Barnum under-feed stoker.

The particular point of interest about this locomotive is that in designing such a locomotive it was realized that to put it in service with a tractive effort of about 72,500 lb., a weight on drivers of over 300,000 lb., and with a grate area of 88 sq. ft. would call for a coal consumption beyond the possibilities of hand-firing.

Five of these locomotives were built in the year 1911 and equipped with stokers, which later proved inadequate in capacity for the requirements and were removed, and the locomotives were put in service in such districts as would permit them to be hand-fired. It was found, however, that they could be hand-fired only by reducing the grate area about 25 per cent by blocking off with fire-brick. These circumstances plainly indicate that on such a locomotive a differential is immediately established between hand-firing, and stoker-firing of at least 25 per cent in capacity. A very gratifying development of this particular situation has been that other stokers were later applied to these locomotives with such success that 60 more have been purchased.

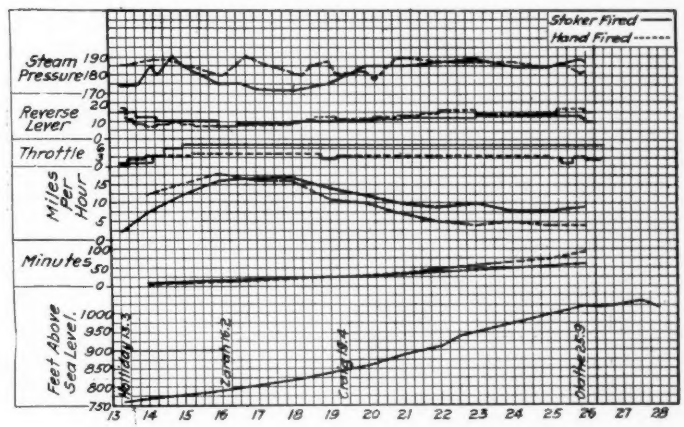


Fig. 2—Hand and Stoker-Fired Tests on 13-Mile Grade

The decision reached by the Burlington as to necessity for a stoker on a Santa Fe type locomotive of this size has practically set the pattern for all such locomotives of this type built. During the past five years over 95 per cent of all Santa Fe type locomotives built for coal-burning service have been equipped with mechanical stokers.

STOKERS INCREASE CAPACITY OF LOCOMOTIVES

Another very early important stoker installation beginning in 1912 was made by the Norfolk & Western on a large number of Mallet locomotives. This installation probably rep-

*Abstract of a paper presented before the Western Railway Club.

resents the most marked increase in revenue tons per train that has been accomplished by any stoker installation made so far. To make a concrete illustration the tonnage rating for the 12-wheel locomotives in service on the Norfolk & Western between Portsmouth, Ohio, and Columbus, which were standard for that division before the advent of the Mallet locomotives was 3,000 tons per train for one Class M-2 12-wheel locomotive, or 6,000 tons for a double-header, whereas when the Mallets were tried out and rated on that division it was found that one of these locomotives could haul 6,000 tons between those two points in practically the same time that one of the smaller locomotives could haul 3,000 tons or two of them could haul 6,000 tons.

It was also discovered that the coal consumption of one of the Mallets was approximately one and one-half times one of the 12-wheelers, which, with twice the tonnage, would make an immediate saving of 25 per cent in coal consumption for any given number of total gross tons per mile.

There is current gossip to the effect that the application of stokers to locomotives means more coal consumption, which, of course, it does from one point of view, as one of the main purposes of the stoker is to make it possible to burn more coal per locomotive mile or per locomotive hour than would be possible by hand-firing. The benefits, however, from such increased coal consumption are such as to make the proposition attractive from every point of view as "movement of tons per day" over any given piece of track is the most important consideration in railroad operation. You only need to refer to the annual reports of the Norfolk & Western for the past five or six years to see what has been accomplished in this direction through the use of larger locomotives equipped with stokers.

The stoker fired H-2 and H-4 Mallet locomotives on the Chesapeake & Ohio have accomplished very similar results

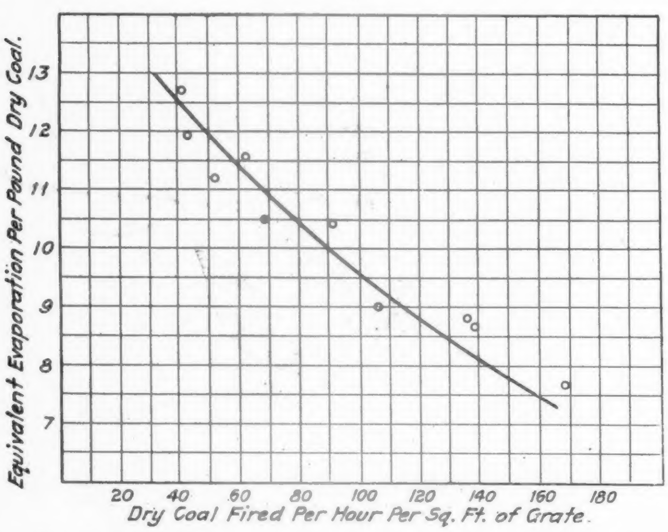


Fig. 3—Effect of Rate of Firing on Equivalent Evaporation

in increased tons per train and the use of over 300 such Mallets in freight service is a further tribute to the value of the mechanical stoker in the assistance it renders in putting into service such locomotives which regularly are operated with a coal consumption beyond the limits of hand-firing.

It is not a question of the pounds of water evaporated per pound of coal altogether, although these particular locomotives show an evaporation, stoker-fired, that comes well within the limits of anything that is regularly accomplished on smaller hand-fired locomotives which are operated anywhere near maximum capacity.

EARLY INSTALLATION OF STOKERS

About the time these Mallets were put in service on the Chesapeake & Ohio 50 heavy Mikados with a tractive effort of approximately 60,000 lbs. were purchased and have now been successfully stoker-fired for over six years. There has been established a differential of 25 per cent between hand-fired and stoker fired tonnage rating on the division where these locomotives are operated. The rating between Russell, Kentucky, and Silver Grove, is 6,000 tons stoker-fired and 4,800 tons hand-fired.

Another very early and important stoker installation was made by the Virginian on somewhat larger Mallet locomotives. These early stoker installations had to do with coal traffic, which, of course, is a low-grade commodity from a freight revenue point of view and the earnings are in more direct relation to the tons per train than is the case with other traffic. The operation of these locomotives in the coal traffic

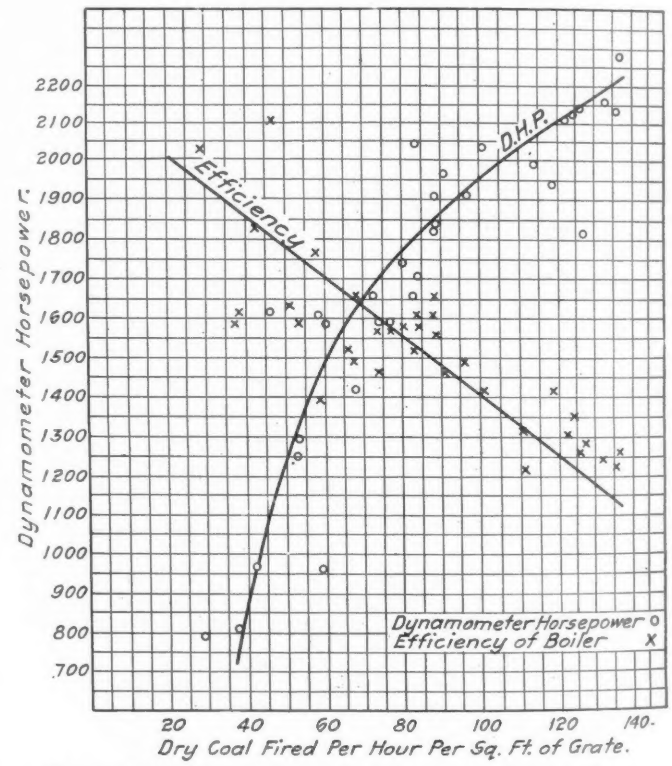


Fig. 4—Boiler Efficiency as Related to Horsepower Chart

on the Virginian has been so successful that special track, special cars, special coal-handling devices at the docks and still larger locomotives have been built to make it possible to increase the gross tons per train still further.

The specifications for the stokers for the Virginian 2-10-10-2 Mallets called for an ultimate coal-delivering capacity of 15,000 lb. per hour as a possibility, and in actual service it is not unusual to have a coal consumption of five tons every 60 min.

The locomotives referred to thus far have all had a calculated tractive effort of more than 60,000 lb. However, a Baltimore & Ohio Mikado which has a calculated tractive effort of only 54,000 lb. represents the largest installation of mechanical stokers to any one type of locomotives up to the present time. The Baltimore & Ohio has over 400 of one design stoker-fired and this locomotive really established the point where the Railroad Administration began the application of stokers to the standard locomotives.

This locomotive not only represents a very important early stoker application as to number of locomotives equipped, there having been 50 of these locomotives equipped as early as 1911, but it also represents definitely the point at which we believe the application of stokers should begin to both new and old locomotives.

STOKERS PROVE ADVANTAGEOUS ON SMALL LOCOMOTIVES

The reason which led the Baltimore & Ohio to apply stokers to such a large number of these locomotives as early as 1911 had largely to do with the fact that the bridges, track, and sidings on the Baltimore & Ohio were such that a locomotive with a heavier axle load than 55,000 lb. could not be operated at many points on the Baltimore & Ohio system. The traffic conditions, however, especially between Cumberland, Md., and Martinsburg, W. Va., which is the throat of the system between the Lines East and Lines West, were such as to require a maximum tonnage movement for long periods of the year to avoid congestion.

At the time the first 50 of these locomotives were put in service on the Cumberland Division 48 maximum tonnage eastbound drag freight trains were operated daily. It will be immediately appreciated that both time and maximum tonnage per train were of immense importance under such stress of traffic conditions. Immediately upon putting into service the stoker-fired Mikados referred to on this division, where a large number of duplicate locomotives were already in operation hand fired, the operating department began to load down the stoker-fired locomotives with heavier tonnage than the hand-fired until within six months after they were put in operation more than 500 tons per train were regularly added to the stoker-fired locomotives over and above the tonnage given to the same locomotives hand-fired.

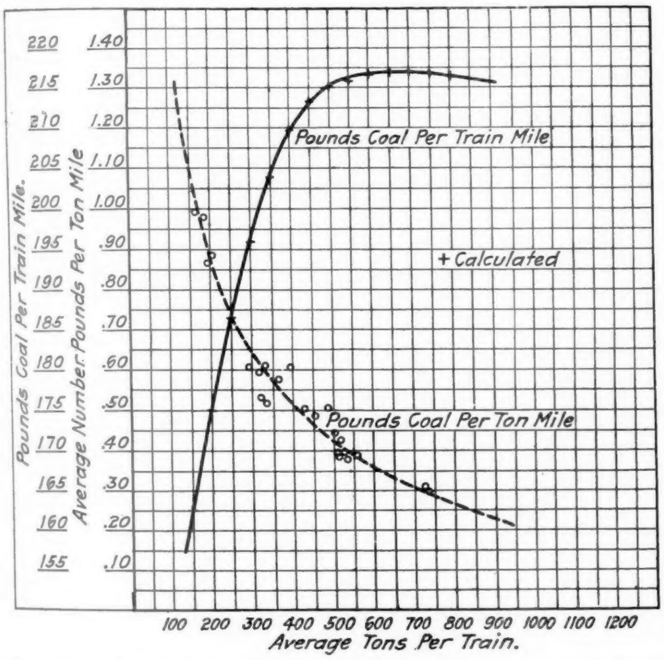


Fig. 5—Relation Between Coal per Train-Mile and Tons per Train

The Baltimore & Ohio at this time owned 160 of these locomotives without stokers and 50 stoker-fired. Since then they have purchased over 300 of these locomotives equipped with stokers which are now in daily service over all parts of the system.

To haul the traffic under the conditions just outlined between Cumberland, Maryland, and Martinsburg, W. Va., an average coal consumption per hour of 6,500 lb. was not unusual for the entire running time between division points, which will readily explain why the stokers have been so successful on the Baltimore & Ohio even on this comparatively small power. When the United States Railroad Administration came to place orders for a large number of locomotives, which included over 600 of this particular type and size, they were also equipped with mechanical stokers which made it possible to use them in such service as I have just described.

The Pennsylvania has a Decapod type locomotive which weighs over 300,000 lb. on drivers; carries 250 lb. steam pressure and has a calculated tractive effort of nearly 90,000 lb. It is of special interest to know that this locomotive was originally designed to be hand-fired and the first one constructed was put in service without a stoker for the reason that it was intended to operate these locomotives only within the limits of coal consumption which could be fired by hand through sustained periods. Over 100 of these locomotives have been built to date and not only the first one which was originally put into service hand-fired, but all of the others have been equipped with mechanical stokers.

COMPARATIVE FUEL ECONOMY OF HAND AND STOKER FIRING

The reason which led up to this application was entirely one of capacity rather than what is ordinarily referred to as economy. The first locomotive originally hand-fired was equipped with a mechanical stoker, and extensive comparative tests made to determine the relative economy of stoker-firing and hand-firing. The chart shown in Fig. 1 indicates the result secured, and confirms the statement that a stoker is not needed to do a job which can be done by hand, nor can the stoker job be done by hand-firing.

It will be noted that within the limits of hand-firing, namely, below 5,000 lb. of coal consumption per hour, there was a slight difference in economy shown in favor of hand-firing. It will be further noted, however, that when the rate of firing in the different tests was increased to where the stoker became a necessity that no difference in economy in favor of hand-firing occurred, and, as a matter of fact, while the hand-firing was of the most expert nature, the capacity was not reached by hand that was easily obtained with the stoker.

A most interesting situation was developed in connection with putting these locomotives into service under actual operating conditions, which was fully to be expected from the results shown in this graphic chart. One of these locomotives was put in service with its rated tonnage on a certain division and hand-fired, the coal consumption noted, and other records made of the performance. Very shortly thereafter another test was made with the same locomotive over the same division with similar tonnage, all conditions being duplicated as far as possible except that the locomotive was stoker-fired instead of hand-fired. The coal consumption, the water evaporated and the horse-power hours developed over the division were almost identical in each instance.

FUEL ECONOMY SACRIFICED FOR INCREASED CAPACITY

There has been much discussion in connection with the application of mechanical stokers to locomotives as to the comparative economy between stoker-firing and hand-firing, and I wish to refer again to my earlier statement that stoker-firing and hand-firing are not directly comparable. The reason for this has really nothing to do with the stokers themselves, but is due to the different points at which the locomotive is worked with hand-firing as compared with stoker-firing.

The significant fact in connection with the comparative tests, however, is that it required 11 hrs. to develop the necessary horsepower-hours to take the train over the division hand-fired, whereas, practically the same horsepower-hours were developed and the train taken over the division in 7 hrs. when stoker-fired. In other words, taking a maximum hand-firing capacity of approximately 5,000 lb. per hr. as a gage of the limit of hand-firing, this would mean that by firing 8,000 lb. per hr. into the fire-box of the same locomotive with the stoker the same number of horsepower-hours could be developed in 7 hrs. that it took 11 hrs. to do by hand.

From the traffic point of view I believe there would be no argument if there were no other considerations than this marked difference in time saved by developing more horse-

power with the stoker on this very large locomotive than was possible to do by hand even with the same measure of economy. One of our engineers estimated the difference in results, however, from another point of view; namely, reducing the tonnage to a point where the train could be handled over the division by hand-firing in seven hours to compare with the heavier train stoker-fired over the same division in seven hours. A very conservative estimate would indicate that on the basis of seven mills per revenue ton income per mile the locomotive would pay for itself in less than 100 trips by being stoker-fired and hauling the heavier tonnage. There has not come to my attention in all of our stoker experience a better example of the real purpose of the stoker than its application to this large lot of locomotives.

SPECIAL SERVICE CONDITIONS MAKE STOKERS NECESSARY

In marked contrast to these large locomotives is a small Consolidation locomotive in service on the El Paso & Southwestern to 21 of which stokers have been applied and which are the smallest locomotives to receive stokers to date so far as I know. They have a tractive effort of but 47,000 lb. The considerations, however, leading up to the stoker application had nothing to do with capacity or economy. The climatic conditions in the desert country during a large part of the year which made it almost impossible to secure firemen to operate such locomotives at all was the main factor so that it was not in any sense inconsistent to apply stokers even to these small locomotives in order to operate them, although I understand the hauling capacity has been actually increased by the stoker application, which it would be very natural to expect under the circumstances.

We come now to a consideration of some of the results which have been achieved by the stoker applications that have been made in different parts of the country and on different locomotives up to this time.

The data shown in Table I. were obtained by the Atchison, Topeka & Santa Fe in tests of a Mikado locomotive having approximately 60,000 lb. tractive effort. This tabulation will serve to bring out some points with regard to coal consumption per hour as related to the hauling capacity of a locomotive of this kind when it is desired to increase the revenue tons per train. The significant points about this

TABLE I—COMPARATIVE TEST DATA, HAND AND STOKER FIRING

Test No.	Tonnage	Cars	Loads	Empties	Running time Hr. Min.	Coal used, lbs.	Evaporation Per lb. coal	1,000-ton miles	Coal per 1,000 T. M.	Coal per hour	Coal per sq. ft. gr. per hour	Average steam pressure	Hand or stoker
7	2,579	65	63	2	6:42	35,000	5.62	281.9	124.2	5,224	78.2	184.3	H
9	2,713	69	60	9	5:48	35,500	5.58	296.6	119.8	6,121	91.3	178.8	S
11	2,849	71	67	4	6:34	46,600	4.75	311.4	149.7	7.096	106.2	175.7	S
13	2,835	74	58	16	5:40	38,083	5.39	306.8	124.3	6,721	100.6	177.0	S
15	2,848	75	73	2	5:38	41,076	4.91	300.1	136.8	7,403	110.8	185.9	S
17	2,896	56	56	0	5:53	43,300	4.73	312.8	138.4	7,360	110.7	185.8	S
19	2,872	71	66	5	6:31	44,890	4.55	310.2	144.7	6,888	103.1	167.5	S
21	2,869	65	65	0	5:28	35,600	4.76	313.6	113.5	6,512	97.7	183.6	S
23	3,059	73	72	1	6:04	37,350	5.03	334.3	111.7	6,156	92.0	179.4	S
25	3,061	65	56	9	6:16	38,250	5.57	334.6	114.3	6.203	92.9	181.2	S
27	2,887	61	57	4	5:27	32,300	5.62	314.6	102.7	5,927	88.7	187.7	S

tabulation are that the coal consumption per hour is fairly representative of the difference between the maximum possibilities of hand-firing and the ordinary range of operation when stoker-fired.

It will be noted that the coal consumption per hour on hand-fired run No. 7 was 5,224 lb. per hr. or 78.2 lb. of coal per square foot of grate area per hour. This brought a coal consumption per thousand ton miles of 124.2 lb. and I believe represents maximum hand-firing possibilities. All of the ten other trips shown on this tabulation show a coal consumption of from 6,000 lb. to 7,400 lb. per hour, and taking the high and low coal consumption per thousand ton miles, the average happens to be for the ten trips almost to a fraction the same as the coal consumption per thousand ton miles for the hand-fired trip, the larger percentage of the stoker-fired trips being below the hand-fired trips in coal per one thousand ton miles. A maximum increase of nearly 500 tons per train was secured on some of the stoker-fired trips, and it will also be noted that on no stoker-fired trip was the actual running time as long as on the hand-fired trip.

SPEED ON GRADES INCREASED BY STOKERS

At the end of one of the runs I took occasion to go into the train despatcher's office, look over his operating sheet, and make inquiries as to the time required by all of the freight

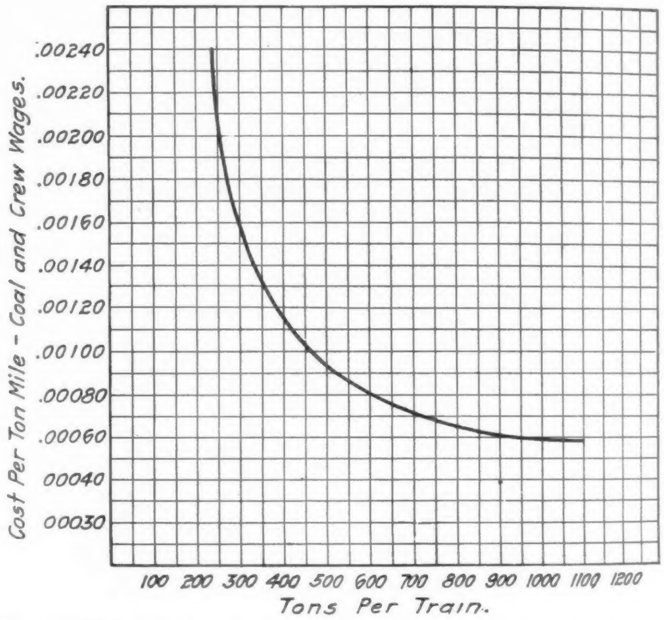


Fig. 6—Cost of Coal and Crew Wages as Related to Tons per Train

trains westbound on that day to cover a 13-mile and an 8-mile 6/10 per cent grade, which grades are the limiting factor on that particular division. The result of that inquiry is shown in Table II.

The 2,900 tons taken up the 13-mile grade in 50½ min. has illustrated better than any description that could otherwise be given the real purpose of the application of a stoker to a locomotive like the Mikado which hauled this train as compared with other similar locomotives hauling from 500 to 1,000 less tons in longer time up the same grade hand-fired. It is true that more coal was consumed in the 50½ min. hauling 2,900 tons in that time up the 13-mile grade than would have been the case if the locomotive had been operated at a less cut-off, less throttle and consequently less speed, but the fact remains that to get maximum tonnage over the division in the minimum amount of time requires this kind of locomotive performance. In addition to illustrating the main purpose of the stoker it also shows why it is quite often stated that from the point of view of water evaporated per pound of coal the coal consumed per locomotive mile is more when stoker-fired than might be the case when such a locomotive was hand-fired under less strenuous conditions.

TABLE II—TIME ON RULING GRADES

Engine No.	Gross tons	13-Mile grade 31.68 feet. Per mile	8-Mile grade 31.68 feet. Per mile
3211	1,800	61 min.	30 min.
3202	2,180	48 min.	27 min.
3207	1,950	63 min.	25 min.
3209	2,900	50½ min.	31 min.
3206	2,120	75 min.	32 min.
3200	1,945	46 min.	31 min.
3121	2,000	58 min.	....
3192	2,285	82 min.	....
3193	1,850	54 min.	....

In order to get a more direct comparison of the possibility of hand-firing and stoker-firing with the tonnage rating such as shown on the stoker-fired trips of the tabulation, and also to compare the performance on the 13-mile grade with the 2,900-ton train, a hand-fired trip was made over the division with what might be called stoker tonnage. Fig. 2 is a graphic chart showing the comparative performance between a hand-fired and a stoker-fired trip. It will be noted that the locomotive was worked at a point stoker-fired which was not possible on the hand-fired trip, the result being that 31 min. more time was required to take the train with stoker tonnage up the 13-mile grade with hand-firing than with stoker-firing.

There are additional points of interest which cannot be plotted by curves namely, that on the particular day on which the hand-fired run was made, the traffic was exceptionally heavy and one manifest and one drag freight train were immediately behind the hand-fired train on the 13-mile grade which would not have been the case had that particular trip been stoker-fired and the 31 min. less time on the hill.

The diagram shown in Fig. 3 illustrates the rate of evaporation as related to the rate at which dry coal is fired per square foot of grate area per hour. The tests indicated on this diagram were all hand-fired so that this drop in the evaporation rate had nothing whatever to do with hand-firing as compared with stoker-firing, but must be definitely borne in mind as usually being related to the price we must pay when we stoker-fire a locomotive to its maximum capacity; in other words, get a coal consumption rate up to the point shown on some of the tabulations.

The next diagram, Fig. 4, illustrates the point even better. The many tests plotted on this diagram were practically all hand-fired, but no better illustration could be prepared to illustrate the price we must pay for operating the modern locomotive to its maximum capacity.

There are many locomotives being operated at the point where less horsepower output is being secured in order to keep the evaporation of water per pound of coal up to a point shown in the left-hand section of this diagram, but on the other hand there are very many more locomotives being operated under the conditions shown on the right-hand section of this diagram and, of course, from the stoker manufacturers' point of view, this is really where we expect a large locomotive to be operated if equipped with a stoker.

The reason that more locomotives are operated at their highest possible horsepower output, notwithstanding the fact that this brings a decrease in so-called boiler efficiency, is, of course, because a very satisfactory return is secured on the price paid for such operation. This price is represented in the cost of coal per locomotive mile, and the returns on the investment are represented in the reduced cost of coal per ton mile brought about by the increase in revenue tons per train hauled by the locomotive when operated at its maximum horsepower output. The curves in Fig. 5 illustrate the relation between the increased cost of coal per locomotive mile and the decreased cost of coal per ton in the heavier train.

This decrease in cost per ton mile is not altogether confined to coal alone as the increased revenue tons per train made possible by the maximum horsepower output of the locomotive is directly related to crew wages as well. Fig. 6 illustrates the decrease in the cost per ton mile of both coal and crew wages combined, and further illustrates why it is desirable to operate freight locomotives to maximum capacity even at an increased cost of coal per locomotive mile.

I have said nothing so far in this paper about the stoker doing the manual work of the fireman or relieving him from the suffering incident to the heat of the fire-box due to opening the fire door when hand-firing, as it has been my endeavor to illustrate the returns which are being secured on the large investment which has been made in mechanical stokers for locomotives during the past six or eight years. It goes without saying, however, that there are many other advantages in the application of stokers to locomotives. One of these is, of course, the relief of the firemen, making the position of locomotive fireman more attractive and, therefore, making it possible not only more readily to secure men for this work, but also to select those men who are particularly qualified later to become locomotive engineers rather than to consider only their physical stamina.

I have tried to be very frank in my statements and have in no sense endeavored to have you reach a conclusion that it is not necessary to pay a certain price for the use of the stokers on locomotives such as have been equipped with them. On the other hand, it is very plain that whatever the price that it is necessary to pay it brings a most satisfactory return from every point of view. Objection can be raised against the stokers, of course, just as objections can be raised to many of the other modern labor-saving and capacity-increasing devices and features which have been added to locomotives in recent years to enable us to travel the avenues of economy which have brought such large returns in present-day railroad operation. The mark which we are aiming at in the application of mechanical stokers to locomotives is mainly one of capacity; and in the sense that the word economy is ordinarily used, we must conclude that the kind of locomotive capacity which I have pointed out must take precedence over economy for large modern locomotives.

It is significant that the cost of coal is after all a comparatively small part of the total operating expenses, and as the economies that occur from any increase in revenue tons per train mile have a much larger influence upon the net annual earnings of any given railroad company than does any variation either up or down of the cost of total coal used per annum by that railroad. It follows that what must be accomplished first and above all other things is to increase the revenue tons per train mile.

LOCOMOTIVE CONDITIONS IN ENGLAND

The condition of the locomotives of the London, Brighton & South Coast Railway, which is considered indicative of the general conditions throughout the country, was made a matter of comment in the London Post of July 1.

It is reported that out of about 600 locomotives there are 166 awaiting repairs. At the same time the traffic condition of this road has increased from 80,000,000 passengers a year before the war to 100,000,000 passengers a year at the present time, or an increase of 25 per cent. This is being handled with a 25 per cent reduction in service and a 20 per cent reduction in force. This company released 5,263 men or nearly 33 per cent of its total force for war service, out of which 2,279 have returned. A large number of those who have not as yet come back are men of technical skill, and this is largely responsible for the retarded repairs. Also many of the skilled workmen have left the railroad to go to the ship yards. This is particularly the case with the boilermakers. At the repair shops at Brighton in July, 1914, there were 70 locomotives under repair with only seven awaiting shop. In May of this year there were 107 locomotives under repair with 59 awaiting shop. The situation is so bad that this company has found it necessary to have locomotives repaired in contract shops. One shop promised to repair two engines a month, beginning with January of this year, but as yet none have been delivered. In addition to the shortage of men, a reduction of working hours has accentuated the difficulty. With the present situation the company does not expect to get back to pre-war conditions for at least another twelve months.

Considerable pressure has been brought to bear for a reduction in fares, but if this were done, traffic would increase beyond the capacity of the company to handle it. The increase in the cost of wages and materials is more than 50 per cent of pre-war conditions.

Railroad Administration News

Shop Men's Wage Negotiations Reach Critical Stage; Standard Freight Cars Being Put in Service

THE railroad Administration has revised the instructions issued early last year that new locomotives being delivered by the builders be sent under steam and hauling tonnage and the regional directors have been given discretion to decide whether new locomotives shall be sent dead in trains or under steam with a load, upon notifying the mechanical department. The question will depend on whether it will be practically useful to use the new locomotives for hauling tonnage that is going in the direction of the locomotives. The use of such locomotives when moving under steam will be accepted as full payment for transportation charges.

SHOPMEN TO TAKE STRIKE VOTE

The 1919 cycle of demands on the Railroad Administration for increased wages has reached a critical stage. Committees representing the various shop craft unions federated under the organization of the Railway Employees' Department of the American Federation of Labor, that presented demands to the director general in January for a wage increase from 68 to 85 cents an hour for the principal classes of craftsmen, as well as increases for helpers and differentials for various classes of special work, were in Washington all of the last week in July conferring with the Railroad Administration officials and threatening strikes unless a favorable decision was forthcoming soon. The unions also demanded the issuance of an order prescribing uniform rules and working conditions. Both propositions have been under investigation for several months by the Board of Wages and Working Conditions, which submitted its recommendations on both to Director General Hines.

On August 1, President Wilson, on the representations of Director General Hines, urged upon Congress the necessity of passing speedy legislation providing for the creation of a tribunal to investigate and determine all questions concerning the wages of railroad employees, but excluding rules and working conditions, and also making its decisions mandatory upon the Interstate Commerce Commission to provide any increase in rates necessary to cover any recommended increases in wages. In his letter to the President, the director general further recommended that Congress be asked to provide in any such legislation that any increases in railroad wages which may be made by the tribunal constituted for that purpose, be made effective as of August 1, 1919, so that the delay incident to the creation of such a tribunal will not be prejudicial to the employees. In his letters to Senator Cummins and Representative Esch, the President expressed his approval of this recommendation.

Prior to this apparent attempt on the part of the Railroad Administration to shift the responsibility of meeting the wage increase demands of the various classes of employees, the shopmen had already been displaying a great deal of impatience because of the delay in passing on their demands and several local strikes had been called.

The labor organizations, generally, apparently did not take kindly to Mr. Hines' proposal and the shop organizations particularly were aroused by the suggestion that any increases be made effective as of August 1 because they had demanded that their increase be made retroactive to January 1, 1919. B. M. Jewell, acting president of the Railway Employees' Department of the American Federation of Labor, announced on August 2 that it had been decided to call for a strike vote, returnable by August 24, of the approximately 500,000 shop employees involved.

Acting on behalf of the six shop crafts a committee of 100, of which Mr. Jewell as chairman presented to the director general on January 7 a request for a minimum of 85 cents an hour for mechanics, an increase of 17 cents; a minimum of 60 cents for helpers, an increase of 15 cents; an increase of 10 cents per hour for apprentices and various differentials for special classes of work. On February 8 the question was referred to the Board of Wages and Working Conditions, during March and April hearings were held by the board, and on July 16 the board made its divided report to the director general. During this period the board was also giving consideration to a demand by the shop crafts for a national agreement covering rules and working conditions, to be effective on all roads under federal control regardless of whether they had previously had contracts with the unions.

These were considered by committees representing the employees and the regional directors, which submitted a report to the board and the board made its recommendation to the director general on July 16.

During June and July several local shop strikes were called by way of protest against the delay in passing on these two matters, but they were settled. Beginning on July 28 the committee of 100 began a series of conferences with the director general demanding a decision by August 1. The unions on the southeastern roads had definitely decided to strike on that date unless their demands were granted. On July 30 Mr. Hines advised the committee he would be glad to enter into the agreement covering rules and working conditions, and promised to give a decision on the wage question later. Mr. Jewell then wired the various local organizations that they had gained one point sought and instructing them that there must be no stoppages of work pending the conclusion of the negotiations. This was not sufficient to hold the men in check, however, and the shop men walked out in various parts of the country on August 1, the number increasing on the following days. The dissatisfaction was increased on that date, when in lieu of a decision on the wage question Mr. Hines read to the committee his letter to the President proposing a special wage tribunal. Meanwhile the negotiations as to the rules and working conditions have been temporarily set aside.

"We shall continue to endeavor to settle the demands by negotiation with the Railroad Administration pending receipt of the strike vote," said Mr. Jewell. "That will, when taken, simply center the power for calling a strike in the hands of the committee. The first effect will probably be the ending of the present strike, which has taken out a considerable number of men over various sections of the country who have been impatient of the long delay. Their walkouts have been unauthorized, but we expect they will return when they see that the organizations intend action in a united fashion."

Approximately 30,000 shopmen in Chicago and 100,000 men in the Chicago district were reported to have left their work at 10 a. m. on August 1 and approximately 35,000 men on 16 railways in the Southeast took similar action. This strike came at a particularly unfortunate time because the Railroad Administration has been bending every effort to put its equipment in condition to meet the demands of the heavy grain traffic. Shopmen in Boston, Philadelphia and

Denver were also reported to have gone out, and the strike spread somewhat on the following day. By August 4 leaders of the shopmen in Chicago declared that 50,000 men were out throughout the country. The shop employees of the Southern Railway at Alexandria, Va., a stragetic location for making an impression on Congress, were among the first to walk out and they were followed on Saturday by the employees at Potomac yard, and on Monday by those at the Washington terminal.

On August 4, B. M. Jewell and other members of the shopmen's committee called on the President at the White House.

STANDARD FREIGHT CARS BEING PUT IN SERVICE

Because of the favorable progress being made in working out the plan for financing the standard equipment ordered by the Railroad Administration through a national equipment corporation, and because of the growing demand for cars, the Railroad Administration has arranged to put into service at once all of the standard freight cars that have been built and that have been kept in storage on railroad tracks near the plants of the builders because of the failure of many of the railroads to accept the allocation of the cars as made by the Railroad Administration. This will put into service several thousand cars, including a large proportion of coal cars, as fast as the cars can be stencilled with the initials of the roads to which they have been allocated. The cars that have been built but not accepted have been paid for by the Railroad Administration as they have been completed, with a deduction representing the cost of stencilling and marking, and the storage has been at the expense of the Railroad Administratoin. It is understood that the cars are being placed in service without opposition on the part of the railroad companies, many of whom formerly protested against the allocations, largely on the ground of their inability to finance them, because the Association of Railway Executives has received assurances from roads representing 70 per cent of the equipment that they will participate in the new equipment trust plan.

Reports of scattering local car shortages are coming from various parts of the country, but while there is understood to be a very large number of surplus cars in the country as a whole the Railroad Administration is unwilling to give out the figures. On June 1 there was a surplus of about 300,000 cars, and it is believed this was considerably reduced by July 1 and still more reduced during July, but the number of freight cars reported as unserviceable for the month of June was nearly 200,000, or 8.1 per cent, although a large number were so reported merely because they were not grain tight and would require little work to put them in shape. Orders were issued late in June to increase the car repair forces that had been reduced earlier in the year in an effort to put the equipment in condition for the summer and fall traffic.

NUMBER OF WOMEN EMPLOYEES REDUCED

The total number of women employed under the United States Railroad Administration reached the highwater mark on October 1, 1918. At that time there were on the rolls 101,785 female employees. The number of women employed on April 1, 1919, shows a decrease of 14.3 per cent as compared with January 1, 1919.

Statistics compiled by the Women's Service Section, giving the number of women employed and the character of their employment since the roads came under federal control have been made public by the director general.

On January 1 of the present year there were on the rolls of the railroads 99,694 women employees, while on April 1 the number had dropped to 85,393. This was due chiefly to the reduction of labor force which occurred in February and March. It was also partly due to the return of men from military service who were reinstated by the railroads.

The statistics show that more than 5,000 women were employed in railroad shops and more than 1,000 in roundhouse work. The latter included, among others, turntable operators and engine wipers. On October 1, 1918, there were 6 women employed as blacksmiths, helpers and apprentices, while a large number of others worked as boilermakers, coppersmiths, electricians and machinists.

The report shows that, considered from the point of view of occupation, the greatest reduction of women employees has taken place in round-houses and shops. Their work in these places was in many cases found unsatisfactory, there being too much heavy physical labor involved.

COST OF FREIGHT TRAIN AND LOCOMOTIVE SERVICE DECREASING

The total cost of freight train service, including locomotive service, continues to show a steady decrease each month as compared with preceding months, although increases as compared with last year, according to the monthly report compiled by the Operating Statistics Section. The combined averages for all regions and the comparative figures for last year and for April, March and February, this year are as follows:

	May, 1919	May, 1918
Cost of locomotive service per locomotive mile	110.3	97.8
Locomotive repairs	37.9	31.3
Enginehouse expenses	9.0	6.6
Train enginemen	19.1	18.1
Locomotive fuel	40.7	38.9
Other locomotive supplies	3.5	2.8
Cost of train service per train mile	156.8	141.0
Locomotive repairs / Enginehouse expenses	53.4	43.7
Locomotive fuel	46.3	44.9
Other locomotive supplies	3.9	3.3
Train enginemen	21.8	20.9
Trainmen	25.1	23.7
Train supplies and expenses	6.4	4.6

	May, 1919	April, 1919	March, 1919	Feb'y, 1919
Cost of train service per 1,000 gross ton miles	103.9	112.7	119.5	126.5
Locomotive repairs / Enginehouse expenses	35.4	38.6	40.8	43.1
Locomotive fuel	30.6	34.3	37.5	40.3
Other locomotive supplies	2.6	2.9	3.1	3.4
Enginemen and trainmen	31.1	32.4	33.5	34.8
Train supplies and expenses	4.2	4.4	4.6	4.8

MAINTENANCE INSRRUCTIONS FOR LAST SIX MONTHS OF 1919

New instructions outlining a working basis for maintenance of way expenditures for the last six months of 1919 have been issued to the regional directors by W. T. Tyler, director of the Division of Operation. While the new instructions are tentative and temporary, in order to control maintenance of way expenditures month by month during the remainder of 1919 to the end that the contract obligations of the Railroad Administration to the railroad companies may be fully complied with but not exceeded, they provide a definite basis on which maintenance officers may proceed as well as prescribing the character of the information which is to be used as the final standard.

While the Railroad Administration takes the position that an excess of expenditures for maintenance of equipment on any road may fairly be considered together with, and as an offset against, any deficiency that may result in maintenance of way expenditures on that road, it is stated that it is not the purpose deliberately to curtail maintenance of way in any respect with this in view and the new instructions treat maintenance of way expenditures on their own footing. Director General Hines has stated that, taking roadway and structures and equipment together, the average condition of the property as a whole is as well off as it was on January 1, 1918. This is because on some roads the equipment had got into a very run down condition at the end of 1917, as the result of the great pressure that had been put upon rail-

road facilities, and it was therefore necessary to make very heavy expenditures in 1918 in order to put it in condition for handling the war traffic, at a time when no one then knew how long it would last. Since the armistice traffic has fallen off and there was a mild winter, with the result that a large amount of equipment put in readiness for the winter is now being stored. A reserve of over 4,000 locomotives has been put in storage and every effort has been made to put the cars in good condition to handle the grain crops. Instructions were recently issued that car repair forces be put on full time at all points where a reduction in hours has been made and special attention is to be given to grain, coal and refrigerator cars in the sections where such cars are most needed.

In connection with figures showing the number of unserviceable locomotives and cars, Railroad Administration officials point to the fact that many locomotives are now reported as unserviceable, which merely require a few hours' work and could be used if necessary and would formerly not have been classified as unserviceable; also that cars which are in storage or are transferred from one region to another to be put in storage for the grain traffic may automatically be transferred to the bad order class because while good for most commodities they require some recoopering to fit them for grain.

The maintenance of way and maintenance of equipment programs are not being treated alike because they represent somewhat different situations. The equipment is being prepared for a possible car shortage this fall, but instructions have also been issued to the regional directors to concentrate repairs on locomotives and cars which by reason of their size can render the most efficient and economical service, to discontinue expenditures on small locomotives and cars not necessary for current use, and for the prospective traffic for the balance of the year, and to confine expenditures on small capacity freight cars to those authorized by Circular No. 20.

ORDERS OF REGIONAL DIRECTORS

Locomotive Maintenance Material.—Northwestern Regional Purchasing Committee Circular 68 states that many locomotives heretofore used on roads other than those to which they belong are now being returned to the owning road and that these locomotives were provided a supply of material for their maintenance peculiar to the individual engine by the using road. It is directed that this material be utilized in lieu of the purchase or manufacture of new material wherever possible.

Traveling Engineers' Association.—The Northwestern regional director, file 77-1-100; suggests that where it is deemed advisable, traveling engineers attend the convention of the Traveling Engineers' Association at Chicago commencing Thursday, September 9. Transportation should be furnished to the men attending and reasonable expenses allowed.

Freight Cars Damaged.—Supplement 1 to Circular 39 of the Southwestern regional director states that 12,183 cars were damaged in yards and trains on Federal controlled railroads during the week ending May 24, 1919, the cost of repairs for which is estimated at $310,764. While this is a substantial reduction compared with one year ago, and is also below the average for the entire year, still further improvements should be made, by closer supervision.

Leaky Western Pacific Cars.—Order 219 of the Southwestern regional director calls attention to claims for loss of grain by leakage from new Western Pacific cars, series 16,801 to 18,300. These cars should be repaired by seeing that there are no short floor boards, that the floors are well fitted around the posts and braces, and that the beveled grain strips are well fitted between the posts and braces and securely fastened to the floor. The side sheathing boards should be well secured by nails to the side-sill nailing timber.

Floor Racks for Refrigerator Cars.—The Northwestern regional director, file 16-1-65, states that Division of Operation, Circular CS43, has been withdrawn insofar as it applies to floor racks for refrigerator cars, and that authority should be received from the Division of Capital Expenditures before ordering material or beginning the application of floor racks in refrigerator cars which are not now equipped with them.

Application of Floor Racks to Refrigerator Cars.—Circular 225 of the Southwestern regional director states that the Division of Capital Expenditures will approve forms for the application of standard floor racks to refrigerator cars not now equipped with such floor racks and which are used for the transportation of perishable freight requiring floor racks for their proper refrigeration, provided such forms are approved by the corporation, with a commitment that it will take care of the finances. This is not to be construed, however, to require application of standard floor racks to cars now equipped with floor racks, except as renewals are required.

Charges for Application of Grip Nut Locks.—Circular 226 of the Southwestern regional director quotes a letter from Frank McManamy, assistant director, of the Division of Operation, relative to an interpretation made by Section 3, Mechanical, of the American Railroad Association that grip unit nuts, which take the place of a commercial nut and a nut lock, but which, under the rule as at present interpreted must be billed either as a common nut at $.035 per lb. or as a nut lock at $.03, are patented manufactured articles and may be charged as such at the net store department cost in accordance with Rule 105.

Repair of Box and Refrigerator Cars.—Supplement 15 to Circular 70 of the Northwestern regional director contains instructions for the repairing of box and refrigerator cars. Car repairing forces are to be at once put on a 48-hour basis at all points where reduction has been made below that figure. Repairers who have been furloughed are to be returned to service and, where necessary, forces will be increased. After the completion of the cars now in the shops, the rebuilding of box cars of 60,000 lb. capacity or less will be discontinued until the bad order cars on hand have been repaired. The Southwestern regional director has issued similar instructions in Order 215.

Safety Appliances on 80,000 Freight Cars.—The regional director, eastern region, by circular 500-92, promulgates a letter from Frank McManamy, assistant director of operation, calling attention to the importance of having all freight cars equipped with United States standard safety appliances by September 1. About 80,000 freight cars now in service need the equipment. These safety appliances are all of standard dimensions, therefore all cars, both home and foreign, should be equipped; there is no loss either of time or material in equipping foreign cars. These appliances constitute a betterment in the interest of safety which can properly be billed against the owners of the cars. Federal managers are called upon to report what progress they are making.

(Orders similar to the above have been issued by other regional directors.)

Pitch and Creosote as Fuel.—The performance of a heating furnace utilizing a fuel composed of pitch and creosote is reported in the engineering supplement of the *London Times.* Two tons of steel billets were heated in 55 to 60 minutes to 2,000 deg. F., using about 16 gallons of the fuel per hour. The internal size of the furnace is 10 ft. by 5 ft. by 3.5 ft. Equal weights of creosote and pitch form the mixture, which is kept at a temperature of 180 deg. F., and, strained through a wire gauze strainer of 40 meshes to the inch, is pumped through an injector type of burner.

CAR DEPARTMENT

THE OPERATION OF THE STANDARD "D" COUPLER

After a number of years of the most painstaking work on the part of the Coupler Committee of the Master Car Builders' Association, with the co-operation of the coupler manufacturers, a coupler design has been evolved which was adopted as standard by letter ballot of the association in July, 1916.

The coupler, known as the Standard "D" coupler, weighs about 400 lb., an increase of about one-third over the types previously in general use. The distribution of this metal, however, has been such that tests indicate an increase of about 100 per cent in the ultimate strength and an estimated service life three times as long as that of the preceding types. This coupler is now rapidly coming into general use and questions as to its operation and construction are of growing concern to car department employees. The following description of the operation of the Standard Coupler is taken from an illustrated booklet published jointly by the several coupler manufacturers.

The coupler is shown in Figs. 1 to 5, arranged for top operation, and in Figs. 6 to 8 arranged for botton operation.

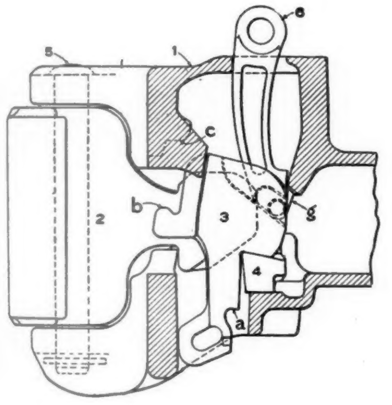


Fig. 1

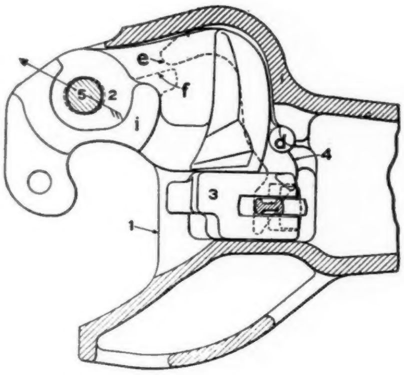


Fig. 2

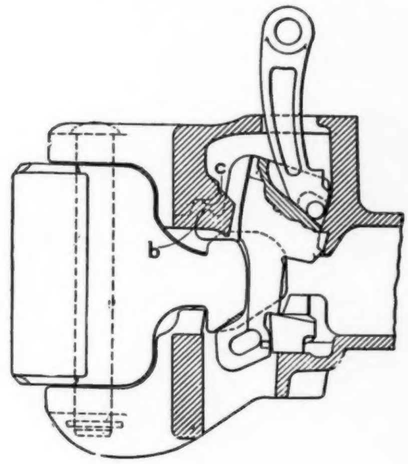


Fig. 3

The essential parts of the coupler are the body 1, knuckle 2, lock 3, knuckle thrower 4, and knuckle pin 5, each of which, except the body, remains unchanged for either type of operation. When equipped for top operation the lifter 6 is used and when the coupler is intended for bottom operation the bottom lock lifter 7 and toggle 8 are used, a cap covering the hole for the lifter 6 and lugs 9 providing a bearing for the lifter 7.

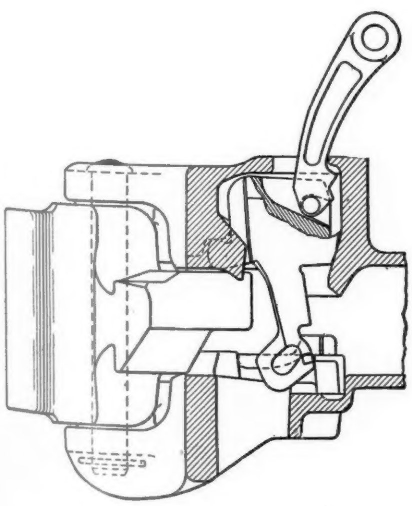


Fig. 4

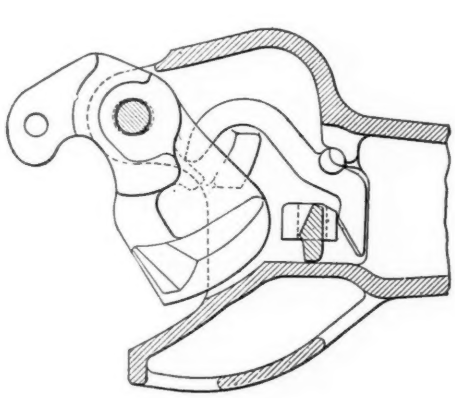


Fig. 5

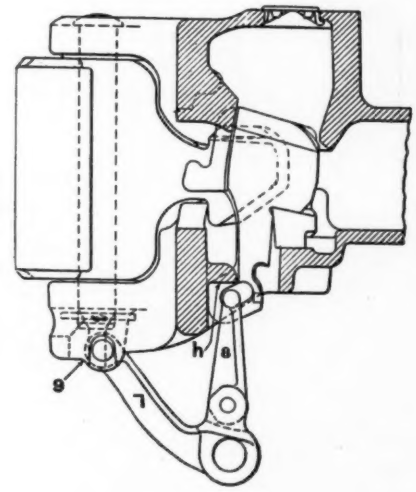


Fig. 6

When in locked position (Fig. 1) the lock rests upon the

top of one end of the knuckle thrower 4, and its head is located between the knuckle tail and inner guard arm wall as shown in Fig. 2. To lockset the lock, it is lifted either by the top lifter 6, or by the toggle 8, until the lockset seat *a* on the leg of the lock becomes level with the top surface of the knuckle thrower, whereupon the leg of the lock tips rearwardly and seats upon the knuckle thrower as is shown in Fig. 3.

In either top or bottom operating forms the lock is lifted at a point to the rear of its center of gravity so that there is always a tendency for the leg of the lock to swing rearwardly as soon as the lock is lifted. To throw the knuckle the lock is lifted above its lockset position until the fulcrum *b* upon its forward side strikes the shoulder *c* within the coupler head. The vertical movement of the lock is stopped by this contact, and the lock is thereafter forced to rotate about its fulcrum, which gives the lock leg a positive rearward movement, which in turn rotates the knuckle thrower about its trunnions *d*. The tip *e* of the thrower contacts the shoulder *f* on the underside of the knuckle and throws the knuckle open.

The lock-to-the-lock or anti-creep function is obtained in the top operated form by the co-operation of the lock lifter with the rear wall of the coupler head as shown in Fig. 1. When the parts are locked the lifter slides rearwardly in the lock until its projection *g* underlies the lower edge of the rear wall of the coupler head. Any upward movement of the lock merely binds this projection between the lock and the rear wall. As soon as the lifter itself is raised, however, it slides forward and upward in the lock and frees its anti-creep engagement. In the bottom operated arrangement the upper end of the toggle 8 (Fig. 6) normally underlies the projection *h* upon the lower wall of the coupler cavity, and thus performs the lock-to-the-lock function. When the lifter 7 and toggle 8 are raised to lift the lock the end of the toggle 8 slides rearwardly and up in the inclined slot of the lock leg and frees the anti-creep engagement.

In order to obtain the strongest possible anchorage for the knuckle within the coupler head and at the same time to allow the knuckle to swing freely when unlocked, the knuckle is provided upon its tail with the pulling lugs *m* and *n*, Fig. 9, which engage the corresponding lugs *o* and *p* upon the upper and lower walls of the coupler head, and serve to relieve the knuckle pivot pin of the greater part of the pulling stress. Above and below the lugs *o* and *p* are the buffing shoulders *q* and *r* against which corresponding shoulders on the knuckle bear in buff.

The forward pull upon the knuckle in draft not only pulls the knuckle directly forward against the pulling lugs, but also tends to force the knuckle laterally in the direction of the arrow in Fig. 2. To resist this lateral pressure the knuckle is provided upon top and bottom with the outwardly extending "pin protector lugs" *i* which enter correspondingly shaped recesses in the upper and lower walls of the coupler head. In order to relieve the knuckle pin of the greater part of pulling and buffing stresses the knuckle pinholes in the pivot lugs of the coupler are elongated slightly, as shown in Figs. 2 and 5, allowing the knuckle to take a firm bearing within the head in pull or buff without stressing the knuckle pin.

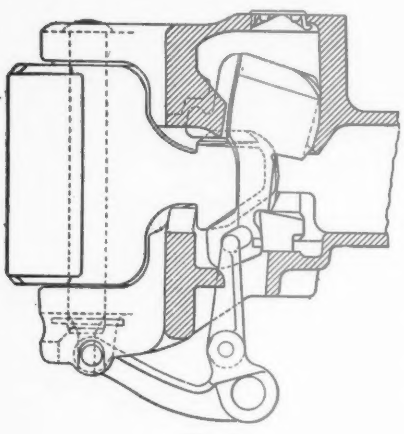


Fig. 7

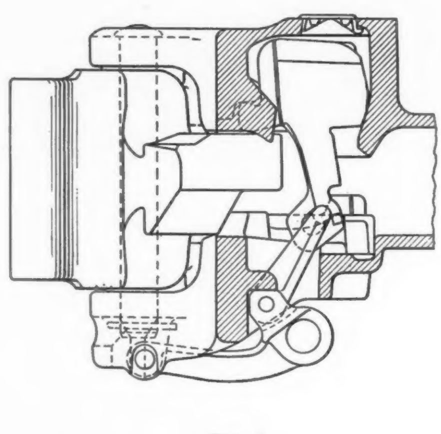


Fig. 8

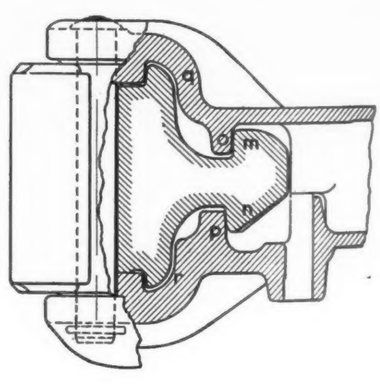


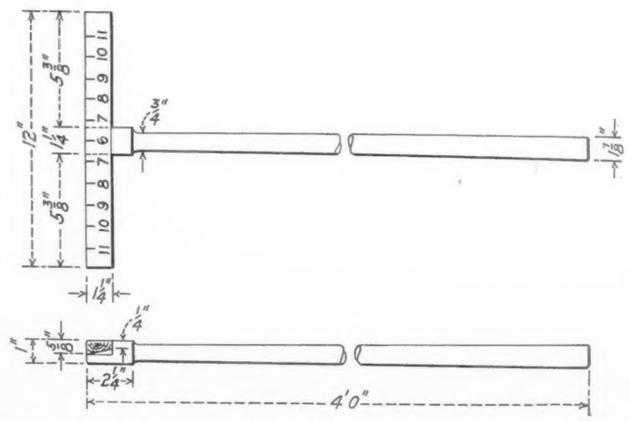
Fig. 9

THE MEASUREMENT OF PISTON TRAVEL IN YARDS

BY T. BIRCH

Air Brake Foreman, C. M. & St. P.

When making the incoming brake test it is necessary for the inspector to go over the train quite rapidly to inspect all the cars before the brakes leak off. Most men are unable to judge the distance the piston travels without going under the car, and for that reason rarely mark a car for brake adjustment unless it has very long travel. In order to overcome this trouble, car inspectors on the Chicago, Milwaukee & St. Paul have been furnished with a device for measuring the travel, which is shown in the drawing herewith. It consists of a scale 12 in. long mounted on a handle 4 ft. long. Both parts are made of seasoned pine material.



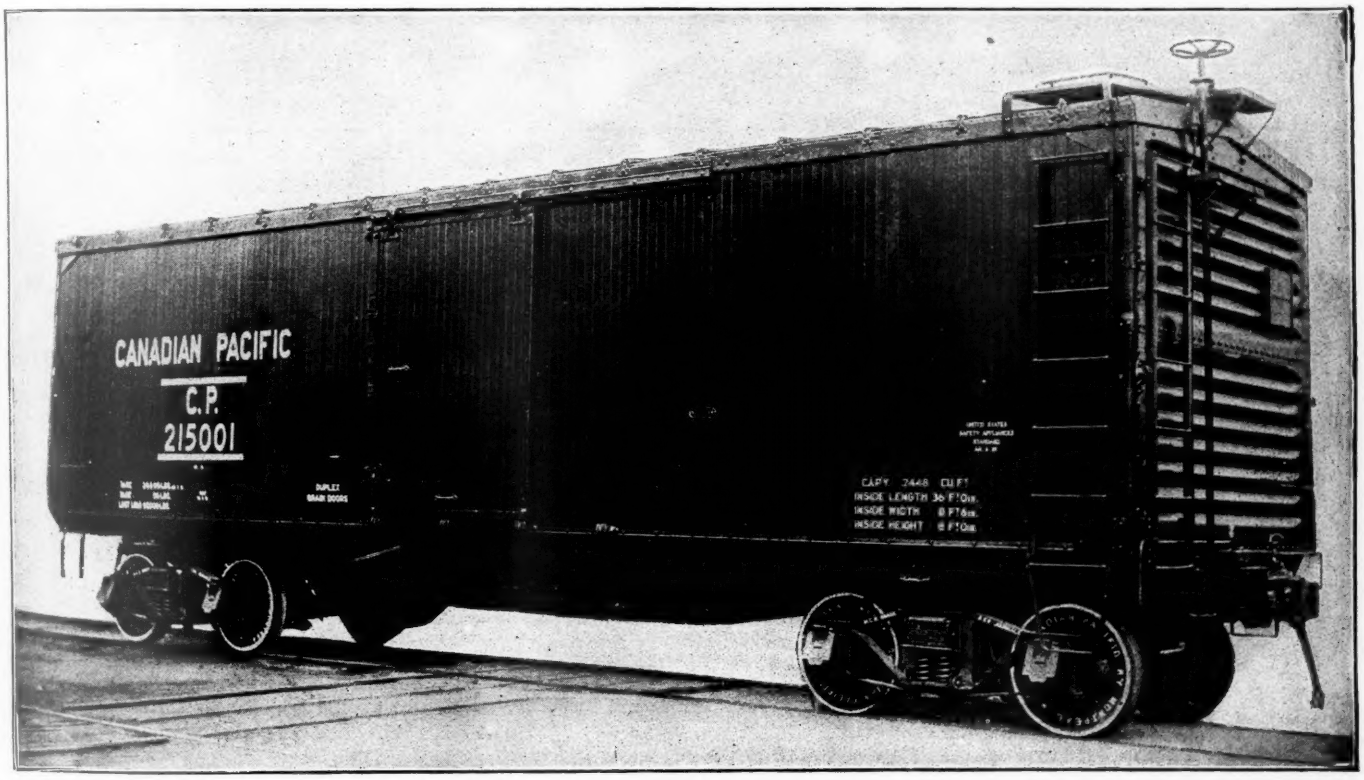
A Convenient Scale for Measuring Brake Cylinder Piston Travel

The scale is painted black and stenciled with white figures once inch apart, the numbers running from the center both ways. By holding the scale against the piston rod the travel can be checked accurately and rapidly without getting under the car.

C. P. R. Double Sheathed Box Cars

Length is 36 ft.; Weight 39,500 lbs.; Have Steel Underframe, Wood Superstructure and Metal Roof

THE Canadian Pacific has built an order of box cars of the steel underframe, double sheathed type, the design of which in a general way is similar to the 40-ton double sheathed box cars designed by the United States Railroad Administration. The Railroad Administration cars, however, have an inside length of 40 ft. 6 in. and a height of 9 ft., with an actual weight of about 46,000 lb. Owing to the very high average box car load in 36 ft. by 8 ft. cars on the Canadian Pacific, the building of cars of these dimensions on trucks with 5-in. by 9-in. journals, with the additional weight which would thus be required, did not seem to be justified. The Canadian Pacific cars, therefore, have an inside length of 36 ft. and a height of 8 ft., the width in both cases being 8 ft. 6 in. An average tare weight of 39,500 lb. has thus been obtained, which represents a saving of over three ton-miles for each car-mile in the movement of loaded or empty equipment, as compared with the Railroad Administration standard car of similar type. The cars have been designed for a limit load capacity of 92,000 lb.



Double Sheathed, Steel Underframe Box Car Built by the Canadian Pacific

UNDERFRAME

Like the Railroad Administration cars the Canadian Pacific box cars have steel underframes built up on center sills of the fishbelly type. The center sills are built up of plates and angles, the web plates having a thickness of 1/4 in., with a maximum width at the center of 25 in. Each plate is flanged at the bottom with two 3 1/2-in. by 3 1/2-in. by 5/16-in. angles and at the top with a single 3 1/2-in. by 3 1/2-in. by 3/8-in. angle riveted on the outside of the plate. The top of the sills is completed with a 3/8-in. cover plate 26 1/2 in. wide, which extends continuously from end to end of the car. Bottom cover plates are also applied at each end, extending from the rear draft gear stop through the bolster construction to a point about halfway down the slope of the deepening section of the sills. These bottom cover plates are replaced for the remainder of the length of the car by the inside flange angles, the ends of which overlap the ends of the plates far enough to provide against weakening the section at the point of transfer.

The side sills are 6-in. by 4-in. by 3/8-in. angles with the horizontal flange at the top and extending outward. The end members of the underframe are 5-in. by 3-in. by 5/16-in. angles with the long flange placed horizontally, resting on the center sill cover plate and on the top flanges of the side sills.

The bolster is of the double diaphragm type. The pressed steel diaphragms are of 1/4-in. material spaced 9 1/2 in. apart, tapering with a slope of 2 1/16 in 12 from a maximum depth at the center of 13 1/2 in. A continuous top cover plate 15 in. wide is riveted at the ends to the side sills and at the center through the center sill cover plate to the top flanges of the sills. Filler diaphragms of 1/4-in. material are placed between the center sills and to these is riveted the center plate support casting. A bottom cover plate extends across the under side of the center sills, terminating just beyond the side bearings. The ends of the bolster diaphragms are secured to the vertical flange of the side sills by means of a filler casting to which all three members are riveted. Intermediate crossties of single diaphragm section are located at points 4 ft. 3 in. from the transverse center line of the car. The diaphragms of these members are of 1/4-in. plate with a depth at the center of 13 1/2 in., which decreases towards the

sides of the car with a slope of 2 1/16 in 12. The flanges of these diaphragms are reinforced with a ½-in. top cover plate 7¾ in. wide, extending across the car above the center sill cover plate, and a short, tapering ½-in. bottom cover plate.

The intermediate floor beams are 4-in. Z-bars, attached at the center and side sills with angle connections and carrying the intermediate longitudinal floor support of 3-in., 6.7-lb. Z-bars, the web of which is placed 2 ft. 8⅛ in. from either side of the longitudinal center line of the car.

THE CAR BODY

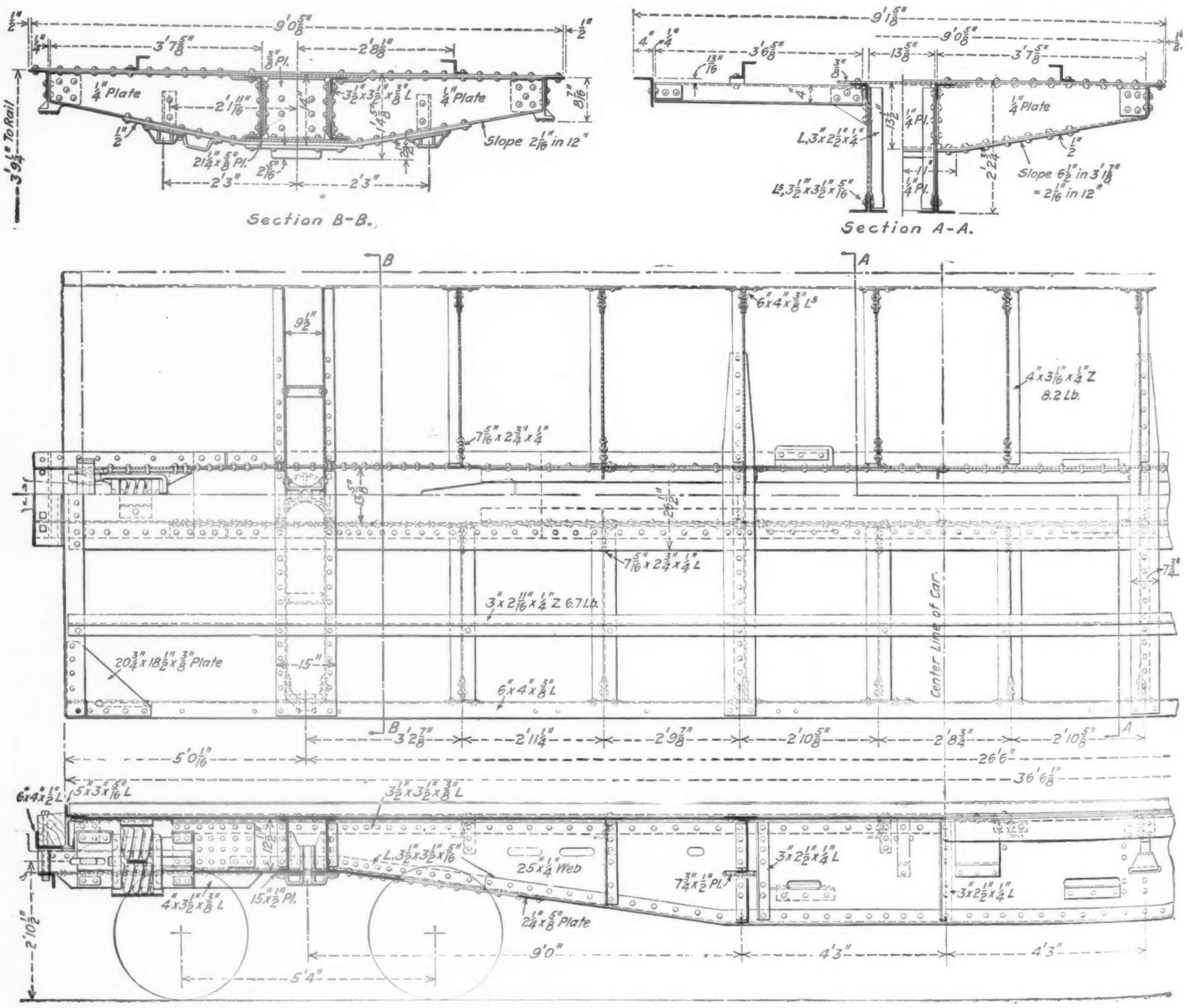
The design of the car body differs from the Railroad Administration cars in that the body frame members are not secured directly to the steel underframe. Above the side and end sills are placed 3⅝-in. wood stringers, to which the post and brace pockets are attached with bolts extending through the steel members. The floor is thus raised above the underframe structure, allowing the use of the intermediate Z-bar supports which have been previously referred to.

The side frame members are three inches thick, wood being used for the posts and braces with the exception of the intermediate posts. The wood posts and braces are of 3-in. by 4½-in. section.

The intermediate posts are 3-in. steel I-beams, these being used for the purpose of providing ample stiffening against bulging when the car is loaded high with grain. The C. P. R. cars also differ from the Railroad Administration cars in that diagonal brace rods are used at each channel section to provide against endwise racking of the car superstructure. The side plates are of 7-in. by 3½-in. section, while the end plate is formed integral with the corrugated steel end of the car.

The outside sheathing is standard 13/16-in. tongued and grooved material nailed in the usual way, and in addition to nailing, it is further secured at the side sill by a steel angle bolted at frequent intervals. There are two girths on each side of the car and the inside lining is carried up to the second girth, 5 ft. 3½ in. above the floor. The ends are lined full height with tongued and grooved lumber 13/16 in. thick, which is placed vertically and nailed to strips secured in the bottoms of the steel end corrugations by means of bolts, the outer ends of which are riveted to the steel end sheet.

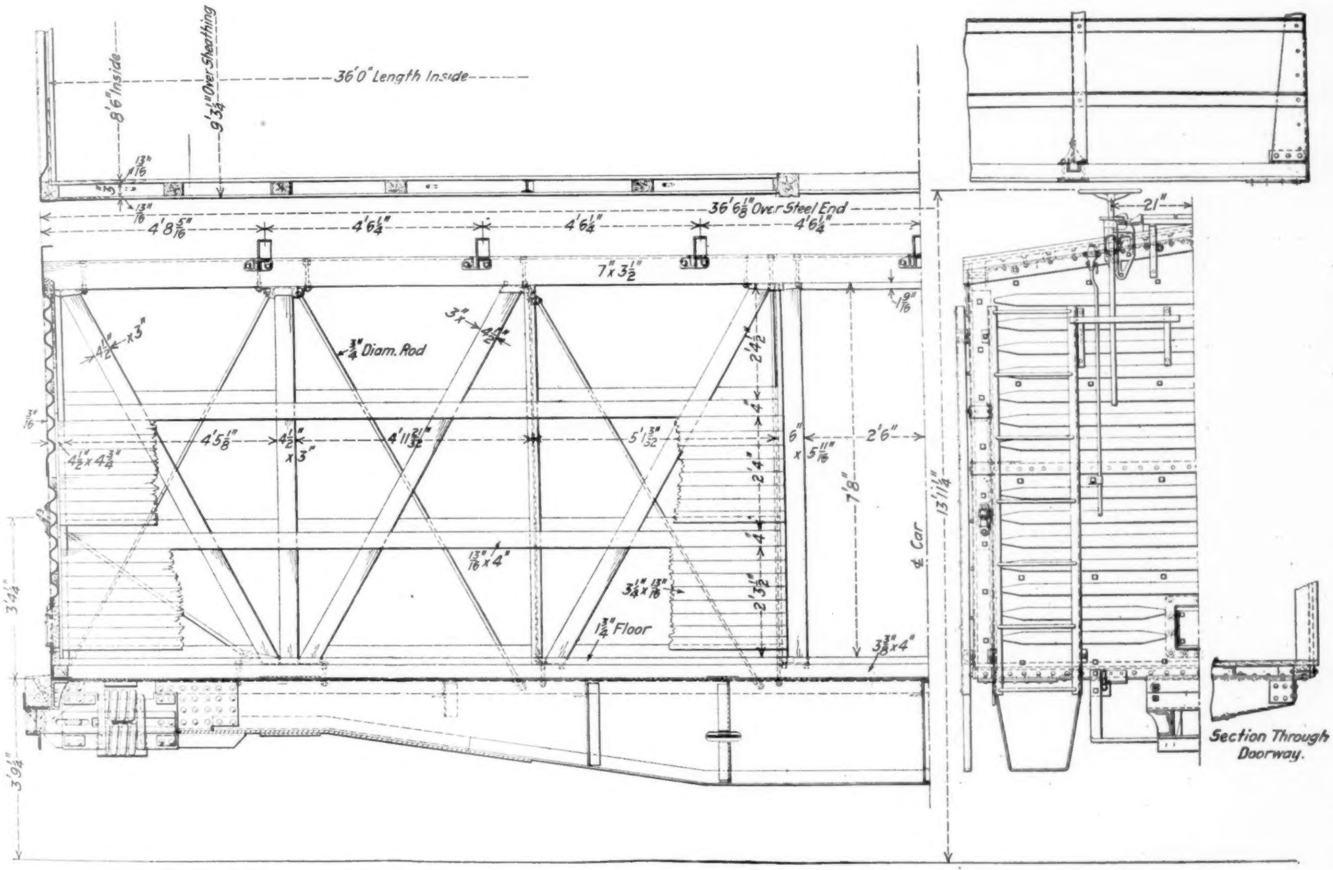
The side door openings are five feet wide. The doors are of wood, bound with metal on all of the edges. The band at the back edge of the door is arranged to engage with the strip on the back door post, forming an effective weather and spark strip and further securing the door from



The Underframe of the Canadian Pacific Box Cars

bulging outward. The front stops are of wood, braced with malleable brackets. The locking arrangement is of the combined lock and stop type equipped with a door starting lever. Two handles are provided on each door, one on the bottom for track level operation and the other near the center girth for platform operation.

Two types of roof are applied to these cars, one an outside metal roof and the other an inside metal roof. The carlines for both roofs are of 4-in. angles, which are attached to the side plates by means of malleable brackets. These brackets are secured to the plate by two horizontal bolts, with the nuts on the inside of the car and the head secured from turning by a flanged double washer plate located back of the facia board.



Sectional Views Showing the Body Construction and Half End Elevation

TRUCKS

The cars are fitted with trucks of the arch bar type with a wheel base of 5 ft. 4 in. and 5-in. by 9-in. journals. The bolsters are the Simplex type with long column guides to provide the maximum area between the bolster and the cast steel truck columns. The trucks are fitted with roller type side bearings.

VALUE OF THE RAILROADS.—According to a series of graphic illustrations showing the value represented by the railways of the United States, as compared with that of all manufacturing industries generally, compiled by E. B. Leigh, president of the Chicago Railway Equipment Company, the value of railway cars and locomotives is $4,137,318,000 and that of manufacturing machinery, tools and implements of all other trades $6,091,451,274. A comparison of the locomotives and cars with all farm implements and machinery indicates that the value of the railroad equipment is nearly three times that of the farming machinery and implements of the country.

SPECIFICATIONS FOR PLATES FOR FORGE-WELDING IN TANK CAR CONSTRUCTION*

The chairman of the Tank Car Committee of the Master Car Builders' Association, A. W. Gibbs, requested Committee A-1 of the American Society for Testing Materials to issue a specification for forge-welding plates suitable especially for tank cars. This matter was referred to Sub-Committee II and initial work taken up with particular reference to the M.C.B. specifications for the Class V tank car.†

In a note appended to the tank specifications it is stated that because of the character of the commodities to be shipped in these cars, it is so important that the tank shall be absolutely tight, that riveted tanks will not be permitted, and all seams shall be welded. The specifications are as follows:

1. *Bursting Pressure.*—The calculated bursting pressure, based on the lowest tensile strength of the plate, shall be not less than 960 lb. per sq. in.

2. *Material.*—(a) All plates for tank, and for dome if dome is made of plate, shall be of steel complying with the American Society for Testing Materials Specifications for Boiler Plate Steel, Flange Quality. For the purpose of welding, the lowest carbon content consistent with the strength prescribed for this quality is desired.

The requirements of the A.S.T.M. specifications for boiler steel, flange quality, are:

CHEMICAL COMPOSITION

Carbon, per cent		....
Manganese, per cent		0.30-0.60
Phosphorus, per cent.	Acid	not over 0.05
	Basic	not over 0.04
Sulphur, per cent		not over 0.05

No increase allowed for check analysis.

*Abstract of the report of Sub-committee II of Committee A-1, on steel, presented at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 24-27, 1919.

†See M. C. B. Proceedings, 1918, page 903, for the Class V tank car specifications. This car is intended for the transportation of liquid products, whose properties are such as to involve danger of loss of life in the event of any leakage or rupture of the tank.

PHYSICAL PROPERTIES

Tensile strength, lb. per sq. in.	55,000-65,000
Yield point, lb. per sq. in.	0.5 tens. str.
Elongation in 8 in., per cent	$\frac{1,500,000}{\text{Tensile strength}}$

Reduction in elongation allowed for increased thickness.

There apparently was some objection on the part of the fabricators to using steel of such high tensile strength for welding; hence a softer grade was proposed. The following specifications were recommended to be adopted as tentative:

CHEMICAL PROPERTIES

Carbon	not over 0.18 per cent
Manganese	0.30-0.60 per cent
Phosphorus	not over 0.04 per cent
Sulphur	not over 0.05 per cent

PHYSICAL PROPERTIES

Tensile strength, lb. per sq. in.	plates ¾ in. or under in thickness	48,000
	plates over ¾ in. in thickness	45,000
Yield point, lb. per sq. in.		0.5 tens. str.
Elongation in 8 in., per cent		$\frac{1,500,000}{\text{Tensile strength}}$

All parties at interest seem to be agreed that carbon becomes a deterrent to good welding when in excess of 0.18 per cent. To encourage the narrowing of the working limits at the mills, it was determined to fix the chemical limits as "check analysis limits," without the 25 per cent excess allowance in the Specifications for Structural Steel for Cars. The sulphur limit was then placed at 0.05 per cent, which is somewhat closer than 0.045 per cent with 25 per cent excess on check analysis allowed in the revisions presented last year. The consensus of opinion is that copper should be left out of the specifications. Limits for silicon, nickel and chromium have been set at 0.05 per cent for each element.

The sub-committee was advised by Mr. Gibbs that "the question of tensile strength is subordinate to that of the welding qualities, for if the chemistry required involves low tensile strength, the specified bursting strength can be obtained by increasing the thickness of the plate." The opinion seems to be unanimous that a soft steel is necessary, the general aim being for a carbon content of from 0.08 to 0.12 per cent for satisfactory welding properties. Having fixed the maximum carbon at 0.18 per cent, and bearing in mind the lower values which are worked to, it was seen that the tensile strength of thick plates would surely drop below 48,000 lb. per sq. in., but that the lowest carbons in the thinner plates would probably not run the tensile strength below 48,000 lb. Therefore, in order to permit designers of welded tanks when plates ¾ in. or under in thickness are used, to have the benefit of this figure, the tensile strengths have been specified at 48,000 lb. for plates ¾ in. or under and 45,000 lb. for plates over ¾ in. in thickness.

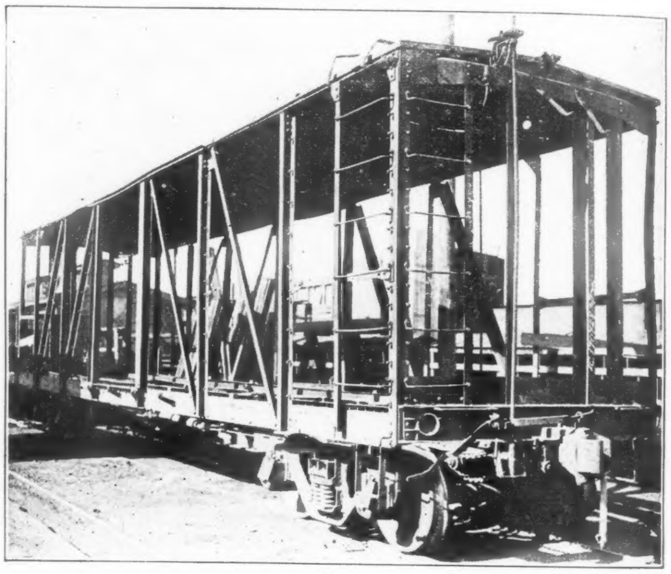
Requirements for elongation, including modifications for thick and thin plates have been made substantially the same as for structural steel for cars. Bend test requirements, however, are somewhat more severe, the bend specimen being required to bend flat on itself through 180 deg. irrespective of the thickness of the plate.

It is believed that the specifications will meet with general approval. Two of the leading consumers of this material, who are manufacturers of tanks for cars by the forge-welding process, are members of the sub-committee and voted favorably. Two manufacturers who are not members of the society were consulted and expressed themselves as favorable.

TECHNICAL MEN UNIONIZING.—Extensive unionization of engineers is predicted in the Chicago Daily News by A. J. Oliver, president of the International Federation of Technical Engineers, Architects and Draftsmen. He says the membership now amounts to 5,000 and before the end of a second year they expect to have three times that number. The organization is affiliated with the American Federation of Labor.

DURABILITY OF STEEL ENDS AND STEEL ROOFS

The ultimate economy of substantial construction of freight cars is shown in a striking manner by some interesting reclamation work which the Illinois Central recently performed. Several months ago a box car belonging to a foreign line was almost entirely destroyed in an accident. The steel



Steel Roofed Car After Passing Through Fire

ends were the only part of the car that could be salvaged and, although so badly bent, were sent to the Burnside shops where they were received in a condition shown in the first illustration. These ends were straightened under a press at a total cost of $13.06 and were later applied to an Illinois Central box car. The condition of the ends after straightening was such as to make them practically as serviceable as when new.

Steel Ends Removed from Destroyed Box Car

A similar instance in which a badly damaged steel roof was reclaimed is shown in the second photograph which gives a view of the framework of a 40-ft. box car that passed through

a fire which completely destroyed the woodwork. This car was equipped with a heavy gage, all steel roof, which as will be noted, sagged badly at the center and also between the side posts. The roof was removed and after being straightened was found to be in such good condition that it was reapplied without the addition of any new material.

What is Modern Malleable Iron?*

A Brief Sketch of Present Day Methods of Manufacture and Characteristics of the Material

BY H. A. SCHWARTZ
Chief Metallurgist, National Malleable Castings Company, Indianapolis, Ind.

During the last twenty years there has been a fairly continuous tendency to substitute for malleable cast iron car parts details made of steel. In view of the fact that the organization with which the writer is connected manufactures both malleable cast iron and steel, this change of policy on the part of car builders is of relatively little commercial importance to the company. Nevertheless, it is a source of gratification to have an opportunity of presenting to a railway organization some pertinent facts concerning the manufacture and properties of malleable cast iron for the information of its members when dealing with promlems of new construction and repair.

Neither steel nor malleable cast iron is best for all purposes. There are many cases throughout all industries where steel is used ill-advisedly in preference to malleable cast iron, and some in which the reverse is true.

All malleable iron made in the United States is produced along the same general lines of manufacture, though there are very considerable differences of quality between the products of various firms according to the degree of skill which each producer possesses in the execution of generally similar operations. It is for the purpose of wiping out as far as may be possible such dissimilarities of quality that the American Malleable Association was formed some three years ago. This organization, maintaining as it does a research committee and a consulting engineer, has been of extreme value to the consuming interests in standardizing and improving the product of its members. At present the association maintains what is practically equivalent to an inspection bureau, which assures the consumer that the product purchased from those of its members in good standing will be of a uniformly good quality, at least equal to the requirements of the American Society for Testing Materials, which requirements are also standard with the United States Railroad Administration and similar organizations.

Up to about 1900 the progress in the production of malleable iron was not well systematized, but there had been evolved methods of procedure which, when carefully followed, yielded results generally satisfactory to the consumers of the period. Prior to this time there had been educated a rather limited number of very highly skilled foremen, who, by extremely close application and extraordinary force of memory, were able to interpret very well what they saw going on in the foundries and annealing departments, and to maintain, one might also say by inspiration, a sufficiently accurate control over manufacturing conditions to cope with the requirements of the time.

At approximately this time there developed a much greater general interest among engineers in metallurgical problems, considerable advance was made in the theoretical side of metallurgy and a number of producers began to attempt the introduction of better methods in their process of manufacture. The writer has been informed that as early as 1893 certain producers of malleable cast iron attempted the operation of a laboratory. Report seems to differ as to just how successful the operation of these early laboratories was and what bearing they had on control of the product which they were supposed to supervise. At any rate, in 1903 the National Company built at its Indianapolis Works a chemical laboratory for the study and control of its product. When beginning this work we found the knowledge of the subject in a rather chaotic condition. Little by little, however, order grew out of confusion, some of the company's other plants began similar work, and the problems of the industry attracted the attention of university men and others doing research work, until at present at least the broad fundamentals of the industry are firmly established, and the reason for all the operations undertaken and the circumstances under which these operations may be expected to be successful, are clearly understood.

PROCESS OF MANUFACTURE

It may not be without interest to know just what steps are taken in well operated plants to maintain the product up to the desired standard, and to safeguard the consumers' interest against inferior material. The pig iron, which is the raw material of the malleable manufacturer, is all bought under chemical specifications and it is required that all deliveries be accompanied by analyses made by the blast furnace chemists to determine the composition of each individual carload or other unit. These analyses are checked on each carload of iron in the consumer's laboratory, and the metal is finally used on the basis of our own analyses rather than the seller's. If, however, by any chance the foundry's analysis differs from the blast furnace's by more than what is believed to be the manipulative error of analytical methods employed, it is customary to take from the carload of pig iron a second sample and to reanalyze this sample for comparison with the first. In this way it is possible to guard very thoroughly against unknown variations in the composition of metal used as our raw material.

Malleable iron is in general made in heats varying in size between 6 and 30 tons in different plants. The usual size is, perhaps, 10 or 12 tons. The chemical composition of the iron as cast is of extreme importance as fixing the quality of the product. Accordingly the combination of pig iron, scrap, etc., entering the furnace is carefully computed to give an average composition such that after the unavoidable change in chemical composition occurring in melting has taken place, the product will be of the quality desired.

As a check upon the melters, each heat is analyzed before the next heat made under the same conditions is put into the furnace, and from such information the melter is enabled to make any necessary changes in the charges entering his furnaces. In some special cases, notably in the electric furnace operation developed by our company, the heat

*From a paper read before the Car Foremen's Association of Chicago.

is analyzed before it is poured into molds, and an adjustment of chemical composition made when necessary to bring it in line with the desired practice.

The product of the foundry in a malleable plant is not, as is frequently supposed, gray iron. Gray iron is not annealable in any commercial sense, and when an attempt is made to apply this heat treatment to gray iron, a totally valueless commercial product results. The castings as they come from the mold in a malleable foundry are entirely white in fracture, are exceedingly brittle, and also extremely hard—so hard that they can not be worked with any other cutting tools than abrasive wheels. These castings are then packed in containers, sometimes surrounded by chemically active packing materials, and sometimes not, and heat treated over an extended period. In general commercial practice this entire heat treatment occupies about one week.

Within recent years most well conducted malleable foundries have adopted the practice of supervising this heat treatment by means of various types of pyrometers. The most successful of these are the recorder type which maintain a continuous record day and night of the changes of temperature. In this way those in charge of the anneal are enabled to check up the work of the night foreman, and the plant executives are enabled to check the methods of the men responsible for the operation of the annealing departments.

Furthermore, there are cast from each heat a number of test bars of the form and dimensions prescribed by the American Society for Testing Materials, and these bars are annealed with the castings. They are then broken as provided by the A. S. T. M. specifications to insure the fact that all the operations have indeed been so conducted as to produce the desired physical properties.

PROPERTIES OF MALLEABLE IRON

The American Malleable Association maintains a testing department under the supervision of Mr. Enrique Touceda, of Albany, N. Y. This laboratory tests every day bars from the plants of the firms which are members of the association. The writer has not taken the trouble to average these results recently, but from general inspection it is quite obvious that the tensile strength of malleable iron as made today approximates 50,000 lb. per sq. in., and the elongation is about 10 to 12 per cent as compared with the A. S. T. M. specifications of 45,000 lb. per sq. in., combined with an elongation of 7½ per cent.

The tensile properties of a material are the most easily determined engineering constants, and are, therefore, generally used as a measure of the quality of a product. In general, however, relatively few structural details are subjected to purely tensile stresses. Rather more common loadings are those causing cross bending, that is, where the structural detail acts as a beam loaded either at the end or at the center, or bearing a distributed load over a greater or less portion of its entire length. It has been determined that the modulus of rupture of malleable iron in loadings of this character is approximately 100,000 lb. per sq. in., and that the deflections before breaking are very great, so great indeed as to prohibitively distort the member before it actually ceases to carry any load. The material can be loaded to approximately half this intensity without passing its elastic limit.

In pure compression malleable iron possesses properties rather closely akin to those of soft steel, since both these materials in the form of short, thick details will carry almost any amount of load in comparison without breaking, though both of them will be much shortened and flattened under the influence of loads of this character. In the form of washers and similar details there is no doubt that the ultimate strength approaches 100,000 lb. per sq. in. Columns and struts made of any material, while, of course, they are primarily intended to bear compression loads, are always considerably weaker than the compression strength of the material would indicate, inasmuch as they fail, not by crushing, but by springing out of line and then bending. Their behavior under loads depends primarily upon the ratio and length to diameter of the column, and malleable iron, of course, is not usually used for columns of any considerable length.

Tests of details supposed to be representative of rather unfavorable design have shown an untimate strength of 25,000 or 30,000 lb. per sq. in. in loadings of this character. In shear, for example, when used as pins, malleable iron has a strength approximately equal to its tensile strength, or perhaps slightly less.

COMPARISON OF MALLEABLE IRON, CAST IRON AND STEEL

By way of a brief summary, it may not be uninteresting to sum up in the form of general statements a comparison of malleable iron with its two competitors, gray iron and cast steel. The tensile strength of malleable iron is approximately three-quarters that of soft steel, its elongation is a little less than that of steel, while in comparison with cast iron, the tensile strength is, perhaps, twice as great as the best cast iron, and the latter material has no permanent elongation in any measurable degree.

In cross bending, gray iron is slightly stronger than either malleable or steel, and steel is slightly stronger than malleable. Malleable iron and steel deflect to the same degree under loads of this character, and both of them distort so much before failure that there is no particular choice between the two materials from this point of view. Gray iron has no deflection under loads of this kind and is inclined occasionally to break without warning.

In compression malleable iron flows out perhaps a little less rapidly than steel, and not quite to the same degree. Gray iron deflects less rapidly than either of the other products, but crushes into fragments at loads which have not deformed malleable or steel to any material extent. Gray iron is valueless under shearing loads, whereas malleable iron has about the same properties as wrought iron, and nearly the same properties as soft steel under loads of this character.

Within the elastic limit the behavior of soft steel and malleable iron, when subjected to twisting, is very much the same. Steel, however, will take a greater twist than malleable iron without completely tearing off, though up to the point where the member is distorted permanently there is no choice between the two materials. Gray iron is too brittle to stand stresses of this character.

Gray iron serves its most useful purpose in the form of columns, where its stiffness prevents the distortion which finally leads to failure by bending. In such cases as, for instance, the queen posts of car construction, this is not as great an advantage as it seems, for the detail may be broken by an accidental blow and, therefore, be rendered inoperative for the stress which is normally applied to it.

Malleable iron will bend sufficiently to permit of its being fitted against adjoining structural details just as readily as steel. When subjected to such tests as bending double, cold, it is not as malleable as soft steel. Such tests, however, are of course not incurred in actual commercial use. It resists shock better and more continuously than either one of its competitors. The most convincing evidence of this fact to a railroad man should probably be its extended use in draft gears, in which the duty of this character is extremely severe. Its microscopic structure is such as to prevent the formation and growth of cracks which cause the failure of a good many structural details of steel under repeated stresses, particularly if these stresses are in different directions.

Malleable iron resists rusting and corrosion to a greater extent than steel; it equals, and sometimes surpasses, cast

iron in this respect, more particularly if the cast iron has been carefully cleaned of sand burned to the surface. In the nature of the case, malleable cast iron is entirely free from any internal strains, due to manufacturing operations, since the long continued anneal to which it has been subjected has of necessity relieved any strains of this character. It furthermore has an advantage in structural details, in that it can be cast of lighter sections than steel, and consequently there are a great many illustrations of railway equipment in which the steel casting is much heavier than would be required to sustain the load because of the relatively greater sluggishness of the metal of which it is poured. The gray iron has to be heavy in order to resist the service strains.

Very usually there exists in the minds of consumers of malleable iron an idea that the strength of malleable iron is all in the skin; that the anneal penetrates only a limited amount, or that malleable is useless in heavy sections—the thought in each case being that there is a limit to the thickness in which malleable iron can be manufactured. Whatever form this idea takes, the conclusion is entirely erroneous. The extreme surface of a test bar of malleable iron is somewhat stronger than the exact center. It is not, however, very materially stronger, possibly 10 per cent, and it is quite possible to make malleable castings several inches thick in which the central portion possesses all the physical properties required by official specifications.

The annealing of malleable iron is not primarily a process involving the removal of carbon from the surface. Such a removal does unavoidably occur, and occurs also in the annealing of cast steel. The actual change brought about by annealing is the destruction of the combined carbon in the original white iron casting by converting it into a special form of free carbon known as temper carbon. This reaction does not start at any one place in a mass of metal any sooner than in some other place, but goes on uniformly throughout the section. Indeed under most commercial conditions combined carbon persists in the surface a little longer than it does at the center.

A much more important point in the design of malleable castings than a question of producing sections which are fairly thin, is to so design the casting as to permit the foundry an opportunity of eliminating shrinks, cracks, etc. Malleable iron is less subject to this difficulty than steel, but considerably more subjected to it than gray cast iron. There are an indefinite number of instances in which draftsmen and designers have decided upon shapes and sections not particularly essential to the use of the detail being designed, which present almost insurmountable difficulties in the foundry. Illustrations of this character are, for instance, wheels having light rims, very heavy hubs and an even number of perfectly straight spokes. It is quite easy to produce a design of a wheel of this character in which the foundry problem ceases to be a commercial one and amounts to the working of a miracle on the part of the molding department to keep the spokes from cracking or from pulling loose from the hubs. Another difficulty frequently encountered is a part so designed as to have in general very heavy sections, and then at a remote and inaccessible point, an important detail of very small cross section. Without going deeply into the metallurgy of the process, it may be said that special efforts have to be made in cases of this kind to make it possible to run the small, thin portion at all satisfactorily, unless this small portion is located so that it can be brought close to the gate through which the metal is poured into the mold. These and similar items are in addition to the usual problems of the design of cast details such as producing a design which does not require the use of cores to produce unnecessary pockets, designs which can be made in a two part flask and other similar self-evident matters.

MODERN REFRIGERATOR EQUIPMENT*

BY L. L. YATES

General Superintendent Car Department. Pacific Fruit Express

The refrigerator car was primarily designed for the transportation of fresh meats for a comparatively short distance, little thought being given to the dimensions or general design. The success which was met with its advent for this purpose, was such as to warrant extending its use for the transportation of other perishable commodities and longer hauls. This necessarily developed the fact that refrigerator cars as originally designed would not meet all requirements.

In the latter part of the nineteenth century, because of the length of the hauls, which increased as more distant markets demanded perishable commodities, and to eliminate as far as possible losses from decay in transit, more thought was given to the design of refrigerator cars as to dimensions, insulation and capacity of ice bunkers. Since that time there has been very rapid development in the design and construction of these cars, which, when properly loaded and handled, will insure the delivery of perishables at distant markets in practically as good condition as when loaded into the car, this being the result of complete co-operation between shippers, the United States Department of Agriculture, rail lines and car lines, which enabled the carriers to determine the proper dimensions, quantity of insulation and type and size of ice bunkers to use.

CONSTRUCTION

The lumber must be well seasoned to prevent shrinkage when framed and assembled. The efficiency, quantity and application of the insulation is of the utmost importance, and has been given more thought than any other feature in the construction of the refrigerator car. It will readily be seen, on account of the belt rails, sills and carlines, that difficulty is encountered in maintaining the continuity of the insulation, which is highly desirable. Particular care is taken in the application of the insulation to the car, to see that it is not only securely applied, but all parts protected, and vertical dead air spaces frequently blocked to prevent circulation within the walls, which, if not prevented, would assist in the absorption or radiation of heat. The insulation in the floor of the car, which is highly important, is more susceptible to damage or deterioration due to the misuse of equipment, such as driving nails or spikes into the floor to brace the load, loading ice or commodities requiring ice in packages, and other commodities which later require the washing of floors, with the result that moisture will penetrate the insulation, affecting not only its efficiency as an insulator, but also the floor timbers, causing rapid decay or deterioration.

The floor insulation itself should be as nearly waterproof as practicable, without impairing its efficiency as an insulator, and when applied should be well coated with an odorless waterproofing compound, with a melting point of not less than 175 deg. F., which must be pliable at zero, highly adhesive when hot and not sticky when cold. This requirement is necessary to meet the extremes of temperatures, both hot and cold, to which these cars are subjected. This waterproofing compound should be liberally used around the side walls at the floor line to prevent capillary attraction in the side-wall insulation.

The side and end sills should be thoroughly coated after framing with red lead and oil, or some other preservative of equal merit. It is also necessary to minimize, if not entirely eliminate, the use of bolts through the insulation, as they afford direct channels for the heat transmission.

The main floor should be of select vertical grain lumber, with the edges laid in white lead and oil and coated with raw linseed oil. Other parts of the interior of the car should re-

*Abstract of a paper presented before the Pacific Railway Club.

ceive one coat of raw linseed oil and two coats of waterproof varnish. The floor, side and end lining around the ice bunkers should receive a coat of mineral paint carrying a high percentage of raw linseed oil to prevent decay from condensation.

There are approximately 140,000 refrigerator cars in the United States, the majority of which have been constructed in recent years, and are built in accordance with recognized designs, suitable for the business for which the cars are intended. There are, however, many older cars that are being made to conform to modern methods of construction.

MAINTENANCE

The Pacific Fruit Express Company owns and operates 15,600 refrigerator cars of the most modern type. To maintain them in a high state of efficiency, each car as it returns to California after a trip East, before being placed for loading, as a rule passes through one of our shops, whether or not it is in need of repairs, where it receives the most careful inspection by specially trained men. Any defects discovered are plainly marked with chalk and written up on an inspection card, which is placed on the car door. Following these inspectors, are repair men, who are trained and skilled in their respective crafts, carpenters making any repairs necessary to superstructures, truckmen on underframes, trucks and brake rigging, tinners making ice tank repairs, upholsterers, side-door and hatch-plug padding, air brake men testing all air brakes and cleaning and repairing all that may require such attention. Car cleaners thoroughly clean the ice bunkers and the body of the car, and if the car contains oil spots or other foreign matter requiring washing, this work is done by another class of workmen. The interior walls and ceiling, if in need of revarnishing, are attended to by painters.

After all this work has been performed, inspectors make an after-inspection to see that the repairs have been properly made and the car is in safe and serviceable condition, particular care being given to the side doors to see that they are perfectly tight. The side doors are then closed and sealed with a heavy wire, and the ventilators set in an open position, permitting thorough ventilation. The car is then ready for service and is marked under the side door with the date on which it is OK'd and reported on the yard report to the general or district agent for forwarding to the loading station.

This work is all performed in the light repair yard. Any cars requiring extensive repairs are switched to the heavy repair yard, or reconstruction shed, where men specially skilled in the art of rebuilding refrigerator cars are employed. Here any wood part or insulation showing decay is removed and replaced with new material, special care being given to the renewing of insulation in a workmanlike manner to see that the vulnerable parts are protected. This work is under the supervision of foremen who have had years of experience in refrigerator car maintenance, and are cognizant of the functions of the refrigerator car.

The location and volume of perishables shipped from Pacific coast points render it impossible at all times to pass cars through our main shops, and in this event, we have inspectors and repair men at the principal loading centers to thoroughly clean and make minor repairs, and cars requiring heavy or general repairs are forwarded to one of the main shops.

In view of the fact that over 100,000 carloads of perishables are hauled annually from Pacific coast points in Pacific Fruit Express equipment, it necessarily follows that each of its 15,600 cars receives inspection and repairs on an average of seven times per year.

Railroad companies realize the importance and necessity of the proper maintenance of refrigerator cars and when they find them in damaged or bad-order condition, requiring extensive repairs to superstructure, as a rule, endeavor to return them to the car owner for repairs, as the owner has the material and trained mechanics to repair them properly.

No doubt many little realize the work and the attention given to the cars that are handling perishables. Any of you who have not been to a well organized refrigerator repair shop would be surprised to see the inspection and attention given to refrigerator cars, minor repairs that you would not consider making on any other equipment. We are fully alive to the highly perishable commodities handled by this equipment and appreciate the necessity of keeping them in a safe, serviceable and sanitary condition. Go into a refrigerator car and inspect the construction and you will find that all parts that would collect any foreign matter and be injurious to the load have been eliminated.

The United States Department of Agriculture has been of very great assistance to the car designers in improving the equipment. Last year the Railroad Administration appointed a committee to design a standard car for the government. That committee was composed of four representatives of the car lines and two from the Department of Agriculture. The car designed for the government was not the car that any of us would want individually. It was the result of take and give on the part of each of us, but I am sure that none of the committee regrets the design finally proposed and accepted by the government. The Railroad Administration has the acme of perfection in the refrigerator car today.

Out of the 140,000 refrigerator cars in the country the majority are good for the purpose for which they are intended. All refrigerator cars are not intended to handle perishables from California. Many of them are for meats and dairy products and short haul runs. Cars that were considered efficient twelve or fifteen years ago are obsolete today for long hauls.

DISCUSSION

L. W. Collins (Refrigeration Technologist, U. S. Department of Agriculture).—For the past year I have been connected with the Pacific Fruit Express Company in carrying on a series of investigations for the committee appointed by the Railroad Administration, to outline and devise a certain method of heating cars to prevent so much damage in transit from cold weather. A plant has been constructed at Roseville where there was developed a type of heating system that was put in the P. F. E. cars last winter. We loaded trains to go through to New York, a fourteen-day trip, and on these trains we had the government system of heating and all the present types of cars on the market. There were six types of heaters. It was found that the fruit temperatures were increased very materially on the top part of the load and freezing at the bottom with the average difference in temperature of 30 degrees F. and in some of the systems there was only 12 degrees between the top and bottom of the load. In the government car during the high winds in Wisconsin there was a difference of 4 degrees. The car companies and car lines have not been able to get the shipments through except on the short lines. In the winter there has been no provision made other than the temporary method for heating the cars and in the years 1917 and 1918 there was an estimated loss in New York City of $1,000,000 worth of food products on account of being frozen in transit. With everyone working along the lines of development in getting the best type of heater, we all hope to be able to very materially reduce the tremendous losses in the winter time that the railroads and the car lines have suffered in the past.

On the car developed at Roseville we have insulated air space and put stringers one and three-quarters inches on top. These were formed to furnish hot and cold air ducts in the center of the car, where the door was so arranged as to carry the heated air from the top to the bottom of the bunker and the cold air was drawn down. There were three different types of heaters, using steam, alcohol and kerosene. Each one had some advantages and it is not yet definitely decided which type is more desirable.

SHOP PRACTICE

ELECTRIC ARC WELDING APPARATUS

BY H. L. UNLAND
Power and Mining Engineering Department, General Electric Company

There are several simple precautions to be observed in the use of electric arc welding equipment whatever the nature of the apparatus may be. Many of the accidents which occur are generally the result of a misconception of the nature of the equipment and its proper use. This applies more particularly to the auxiliary apparatus.

The eyes should be thoroughly protected by a mask from the light of the arc or serious burns to the interior of the eye will certainly result. No chinks or holes in the mask should be permitted since only a brief exposure of the eyes is required to bring on painful results. The inside of the mask should be kept painted dull black to prevent reflection of the light from behind.

The mask consists of a thin sheet of aluminum formed to the proper shape and provided with an adjustable band for supporting it from the operator's head. An opening in the front of the mask is provided for a window of glass, which may be either a number of individual sheets of different colors or a single compound sheet of glass.

The colored protective glass should be sufficiently dense to reduce the light intensity to a value not objectionable to the eye and at the same time the area immediately around the arc should be sufficiently clear to enable the operator to properly follow the work. Different color combinations are used but the most general seems to be a combination of red and green glass.

The glass is held in a recess in the front of the mask by means of a clamping frame so that the light from the arc cannot pass through joints or cracks around the edge of the glass, as a small amount of light coming through one of these openings would in a short time affect the eyes of the operator.

It is advisable to keep a piece of clear glass on the outside, since, in welding, this outside surface will be struck by particles of molten metal, and will become roughened to such an extent that it becomes useless and must be replaced.

A hand shield is principally used in doing metallic electrode welding. It consists of a light wooden frame with provision for a protective glass window similar to that used in the mask. The shield is also used by inspectors and others who require the protection only for short periods and at infrequent intervals. A light box frame surrounding the window is fitted to the operator's face, preventing light from the side or rear reaching the operator's eyes, thus eliminating any interference of a number of operators due to the light from the arcs. The protective glass of the hand shield is supported in guides on the front of the shield and is clamped in place by a wooden wedge driven through openings in the guides.

ELECTRODE HOLDERS

The function of the electrode holder is to electrically connect the electrode to the cable connected to the welding equipment. The requirements of this service are: It must securely grip the electrode so that the welder can operate it without play in the mechanism or without the electrode becoming loose in the holder while in use; the clamping arrangement should be such as to facilitate changing electrodes; it should be so constructed that the minimum heat reaches the operators' hand; the weight should be as low as possible and the balance such as to facilitate manipulation by the operator; the construction should be such that the operating parts are protected from accidental contact to avoid injury by burning or by being struck, and the general construction should be substantial to avoid bending or jamming.

ELECTRODES

Carbon electrodes should be rods of hard, homogeneous uncored and uncoated carbon. The diameter used will vary with the current to be used and this information is given elsewhere. The length depends on the particular class of work to be done. Long carbons reduce the percentage of short ends thrown away, but are more liable to breakage. The average lengths range from 9 to 12 in.

For welding iron and steel the metallic electrode should be a high grade of low carbon steel wire. A large number of tests were made by the Emergency Fleet Corporation to determine the best chemical analysis of wire for this purpose, and the wire now made by a number of manufacturers meets these requirements. This material can be purchased either direct from the makers or through jobbers and can be obtained either in rolls, or in short lengths cut and straightened. In ordering, "electric welding wire" should be specified, since wire for acetylene welding is often treated in such a way as to render it unsuitatble for electric welding.

The electrode wire should be cut into pieces convenient for the operation. A length of 18 in. is satisfactory since it is about the greatest length an operator can handle, and at the same time it reduces to a minimum the number of times the electrode is changed, and consequently the wastage.

CABLES

On account of the intermittent nature of the work it is possible to use smaller cable for the welding circuits than is standard for the current capacities. In this way, there is also a gain in flexibility which permits better control of the welding arc, by facilitating the manipulation of the electrode holder.

In metallic electrode welding a length of at least 15 ft. of extra flexible cable should be connected to the electrode holder to allow the operator to fully control the arc through manipulation of the holder. For the ground or return cable the standard extra flexible apparatus or dynamo cable insulated with varnished cambric for low voltage circuit and covered with double weatherproof braid has been found suitable.

The carbon electrode welding arc is not as unstable as the metallic arc and therefore the manipulation of the electrode is not so important. For this reason the standard extra flexible dynamo cable referred to above may be used for connection to the electrode holder, as well as for the return circuit.

It is difficult to give universally applicable figures cov-

ering amperes, speed, etc., for electric arc welding, due to the effect of conditions under which the work is done, the character of the work, and to a very large extent the skill of the operator.

The following figures are based on favorable working conditions and a skilled operator. However, they are approximations only and are given here merely as a general guide.

CURRENT REQUIRED FOR METALLIC ELECTRODE WELDING

Light work	25 to 125 Amperes
Heavy work	up to 225 Amperes

Electrode diameter, in.	Amperes	Plate thickness, in.
1/16	25-50	up to 1/16
3/32	50-90	up to 1/4
1/8	80-150	1/8 to 3/8
5/32	125-200	1/4 up
3/16	175-225	3/8 up

The same size electrode may be used with various thicknesses of plate, but the heavier plate will require the use of the heavier currents.

Approximate speeds of welding sheet metal with the metallic electrode are given in the following table:

Thickness of plate	Speed, ft. per hour	Cost per ft.	Comparative cost per ft., acetylene
1/16	20	2.12	1.78
1/8	16	3.12	4.66
1/4	10	7.13	13.1
3/8	6.5	12.3	36.1
1/2	4.3	19.8	much higher
3/4	2.0	41.7	much higher
1	1.4	61.3	much higher

The above figures are based on average figures for materials and labor. They will probably vary considerably for different localities, and will vary slightly with the type of equipment, but the relative costs of gas and electric welding will in general hold true.

CARBON ELECTRIC WELDING

The carbon electrode can be used for welding and for building up metal in a large number of cases where the metal is not subjected to high strains or where it is under compression only. This process can also be used to a very large extent in rough cutting of plates and in cutting away parts of structures.

The average current ranges for different types of work are as follows:

Light welding	150 to 250 amperes
Medium welding	250 to 350 amperes
Heavy welding and medium cutting	400 to 600 amperes
Very heavy welding and heavy cutting	600 to 1,000 amperes

The maximum values of current permissible for the carbon electrodes are as follows:

Diameter of electrode	Maximum amperes
1/4 in.	100
1/2 in.	300
3/4 in.	500
1 in.	1,000

Graphite electrodes permit the use of somewhat higher current densities but the higher cost of graphite electrodes is a serious handicap to their use. Lower currents than those given may be used, but higher values will result in undue burning of the electrode.

For depositing or building up metal, by means of the carbon arc, or flat surfaces where the work is accessible and all conditions favorable, the following figures may be used:

Current, amperes	Lb. per hour	Cu. in. per hour
200	1 1/2	5.4
300	3	10.8
400	4 1/2	16.2
500	6	21.6

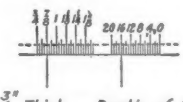
For continuous work the above figures may be used, but for short jobs of ten minues or less the rate will be double the amounts given.

DEPTH OF CUT FOR WHEEL LATHE

BY J. E. OSMER

A convenient method of determining the depth of cut for a wheel lathe is in use at the Owosso shops of the Ann Arbor Railroad.

The wheel or tire is placed in the lathe and the nose of the tool forced against the tread at the lowest point of the contour. The side of the crosshead and carriage is then



Flange			Depth of Cut	
Flange	3/4"	Thick	Depth of Cut	20/32
"	13/16"	"	" " "	18/32
"	7/8"	"	" " "	16/32
"	15/16"	"	" " "	14/32
"	1"	"	" " "	12/32
"	1 1/16"	"	" " "	10/32
"	1 1/8"	"	" " "	8/32
"	1 3/16"	"	" " "	6/32
"	1 1/4"	"	" " "	4/32
"	1 5/16"	"	" " "	2/32
"	1 3/8"	"	" " "	0

Measure Thickness of Flange 1/4" Above Tread.

Turn Tire Having Thinnest Flange First. And Tire from Left Main Second, as this Last Mentioned Tire is the One that Develops a Flat Spot, Due to the Slip of Wheel, When Piston is in Extreme Foreward Position on Left Side

Table Showing Depths of Cuts for the Wheel Lathe

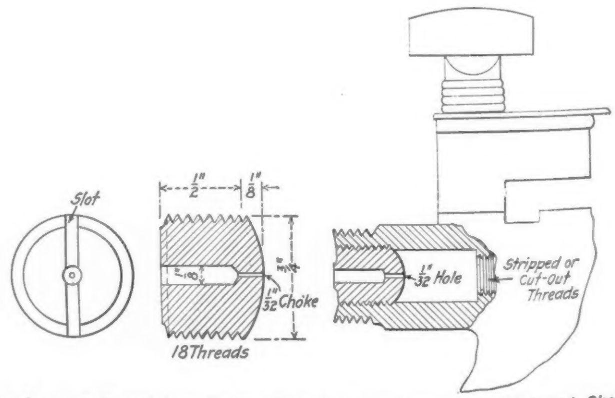
chalked and the position marked with a sharp lead pencil. The tool is then withdrawn, moved to the edge of the tire and the cross slide extended forward to the pencil mark. To this is added the depth of cut as indicated in the appended table, thus giving the total depth of roughing cut required.

REPAIRING LUBRICATOR CHOKE PLUGS

BY F. W. B.

The threads in the body of a bull's eye lubricator which take the choke end of the reducing plug, when stripped or cut out by steam are sometimes very difficult to repair. A practical improvised method of making such repairs is shown in the sketch.

The inside of the plug recess will take an 18-thread, 3/4-in. tap and clean up with a satisfactory thread; it is necessary to tap it back for only about 5/8 in. The plug, which is also



Method of Repairing Bull's Eye Lubricators with Stripped Choke Plug Threads

shown in the sketch, is made and screwed firmly into this threaded recess. A slot can be sawed in the outer end of the plug to permit the use of a screw driver to put it into place or remove it for cleaning. The plug hole in most cases will be found sufficiently large for the tap, yet small enough to make no difference in the size of the oil pipe tail piece joint. This method of making repairs has been used in a number of cases by the writer with very satisfactory results.

JACOBS-SHUPERT FIREBOX REPAIRS

The Methods and Tools Used to Repair the Stay Sheets and Cracked and Distorted Sections

BY H. LOUIS HAHN

THE most common defects which first develop in Jacobs-Shupert fireboxes, are cracks in the inside firebox sections. They generally develop where the most heat is concentrated and are from one to six inches in length. On some engines in certain territories as many as 100 cracks have developed during the periods between shoppings. In other territories there are boxes of this type which have given seven years' service without developing any cracks of this kind.

A method of repairing these cracks, as shown in Fig 1, has been used very successfully and is now the standard method of repairing cracked firebox inside sections. A piece of the section large enough to include all of the cracks in that particular part of the section, is cut out as shown at *A*.

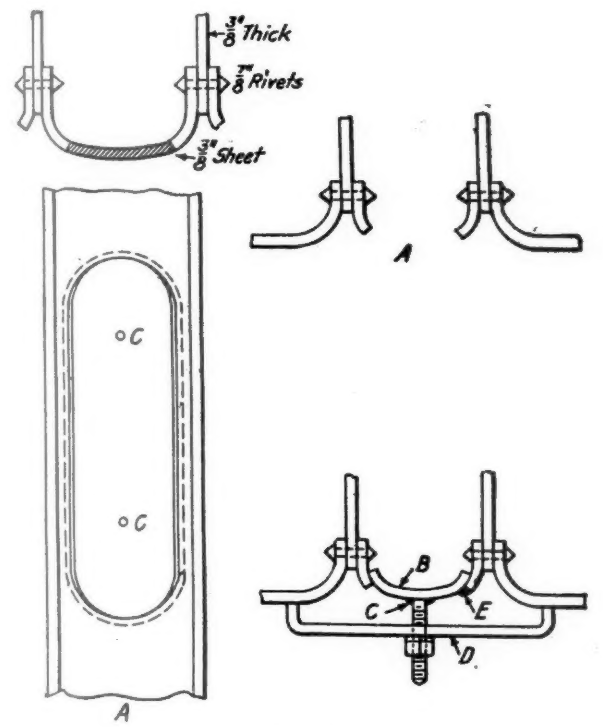


Fig. 1—Method of Patching Firebox Sheets

A patch of 5/16-in. firebox steel is then formed to fit on the inside of the section, as shown at *B*, lapping over the inside 1/4 in. all around. To facilitate the handling necessary to make a good fit of the patch, one or two 3/4-in. bolts six inches long, having had the heads sheared off, are welded to the patch as shown at *C*. Only one bolt is necessary for a short patch, but on long patches they should be spaced about 12 in. apart.

After the patch is properly fitted, the clamp or clamps *D* are applied to hold the patch in the proper position while it is welded in by either the gas or electric process. The edge of the old sheet is welded to the new patch as shown at *E*. The ends should be welded first and the sides last, as the curved surface of the sides will compensate the strains due to contraction of the cooling welds more easily than the ends. As much of the welding as possible is done with the clamps *D* in position. The writer has applied patches up to 48 in. in length, welded with the gas torch, which have been running two years without any leaks developing. The same method is used for cracked sections on the curve of the crown sheet side roll. In the center of the crown sections defects arising from low water, such as stretching of the sections, are repaired in the same manner. These patches meet the requirements and approval of the Interstate Commerce Commission Division of Locomotive Inspection.

The first solid stay adjacent to and on each side of the center sling stays will develop cracks under the top outside sections, as shown at *A* in Fig. 2, after the firebox have been in service. The method of repairing such cracks consists of flanging 3/8-in. brackets *B* and riveting them to the outside sections as shown, using bolts to fasten the brackets to the stay sheet.

A very common defect is the cracking of outside top sections through the center line of the rivet holes, between the holes. Cracks develop first in the section adjacent to the throat sheet connection sheet and in succeeding sections back to and including the fifth section, in some cases, as shown in Fig. 3. A number of years ago when these cracks first developed it was thought that they were the result of anchoring the backhead braces on lugs riveted to these sections. After the cracked outside sections were renewed braces were anchored ahead on the throat sheet connection sheet as shown in Fig 3 and flexible flue sheets applied. These same renewed sections are developing cracks in the

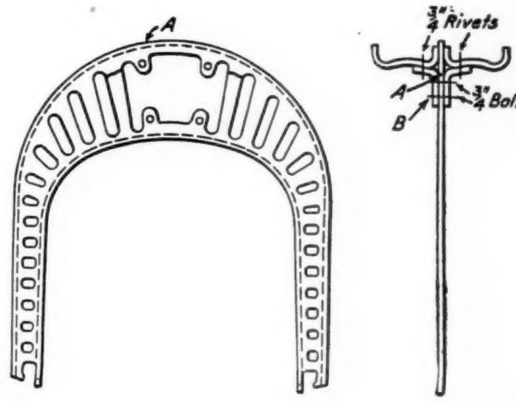


Fig 2—Stay Sheet Repairs

Fig. 5—Scale Tool

same places as the original sections and necessitate the renewal of the part sections previously applied.

The defective parts of the sections are removed, the new part sections are fitted and the joints are butt welded to the old portion of the sections with the gas torch.

When any part of the inside sections become defective and cannot be repaired as shown in Fig. 1, the method shown in Fig. 4 is used. A portion of the outside section opposite the defect in the inside section is cut out and the edges chipped bevel. The cutting torch is used to remove the piece, but where this is not available it may be cut out with an air hammer and chisels.

After the cracks in the inside section, or whatever other defects there may be, are repaired, the piece of the outside section which was removed is fitted in place, beveled, welded

and riveted and caulked. This method may be used for any part of the outside sections. The object of the diagonal cut is that, during the operating of welding the piece in again, there will be no strains resulting from cooling welds, the line of contraction being horizontal instead of vertical. The same method of the diagonal cut is now followed in applying new top sections as shown in Fig. 3.

A defect which often develops soon after these fireboxes go into service is the cracking of door sheet and flue sheet stay sheets in the right and left water legs, adjacent to the outside sections. These cracks start in the corners of water circulation cut-outs and gradually run upward and downward at an angle of about 15 deg. until they meet and form one continuous crack. They can readily be discovered by holding a flash light in the corner washout plug holes just above the mudring.

A method of repairing the door sheet stay sheet is to cut the backhead sheet between the first two vertical rows of staybolts high enough to remove a piece of the side roll of the backhead from the mudring up, so that the defective portion of the door sheet may be uncovered. Then either chip out the cracks in the door sheet and weld them, or apply a

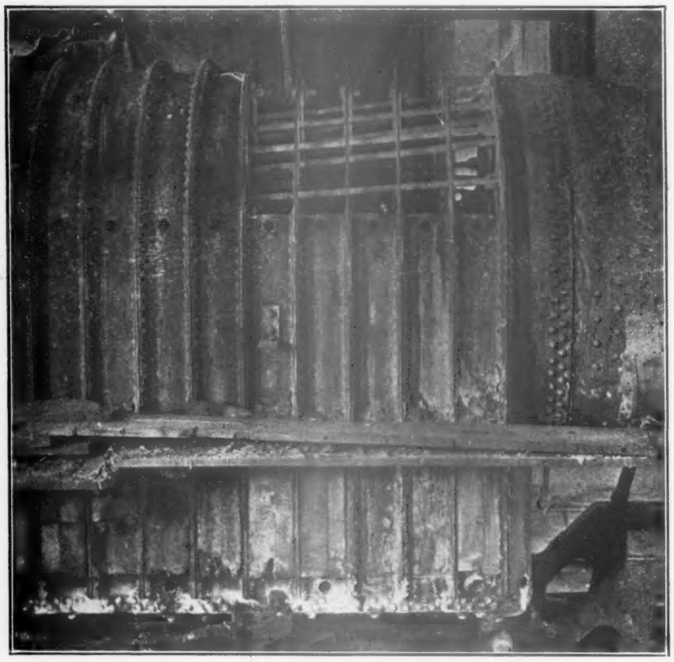


Fig 3—Defective Outside Top Sections Removed

new piece of door sheet and weld it in. After the repairs to the door sheet are made, replace the piece cut out of the backhead sheet, first applying it with temporary bolts, then weld the butt joint and then rivet and caulk the sheet at the mudring.

For flue sheet stay sheet cracks in the side water legs the method of repair where a new sheet is not necessary is shown in Fig. 4. Cut out a piece of the outside section and weld the cracks in the stay sheet. When it is necessary to apply a new flue sheet stay sheet, the firebox back end is disconnected at the throat sheet connection rivets and the back end loaded on a car to facilitate handling. The flue sheet, including the defective portion in the side water legs is removed and the new sheet laid out, punched and applied When a flue sheet stay sheet only is applied to the back end, it is not necessary to remove the outside section to drive rivets in the inside section; a holding on bar is used instead. This bar is bent on the end and made small enough to go through the water circulation cut-outs. Rivets are then applied from the rear side of the flue sheet and driven from the front side. After the flue sheet is riveted to the firebox section, the firebox back end is raised and reapplied to the boiler at the throat sheet connection and riveted and caulked. An alligator hydraulic riveter is used to apply rivets in the outside section, but it is possible to countersink the holes and drive the rivets with an air hammer. One firebox had three new outside top sections, a new flexible flue sheet and a new portion of staybolt section of flue sheet stay sheet applied at the same shopping.

To renew a complete inside section, start at the flue sheet end and remove stay sheets and both outside and inside sections, one at a time, until the defective section is reached. Remove one more outside section than the number of inside sections, so that the riveting machine can be brought to the work to rivet the new inside section after it has been fitted. Then fit up the old inside sections and stay sheets, applying them in the same order as removed, so that the stay sheets

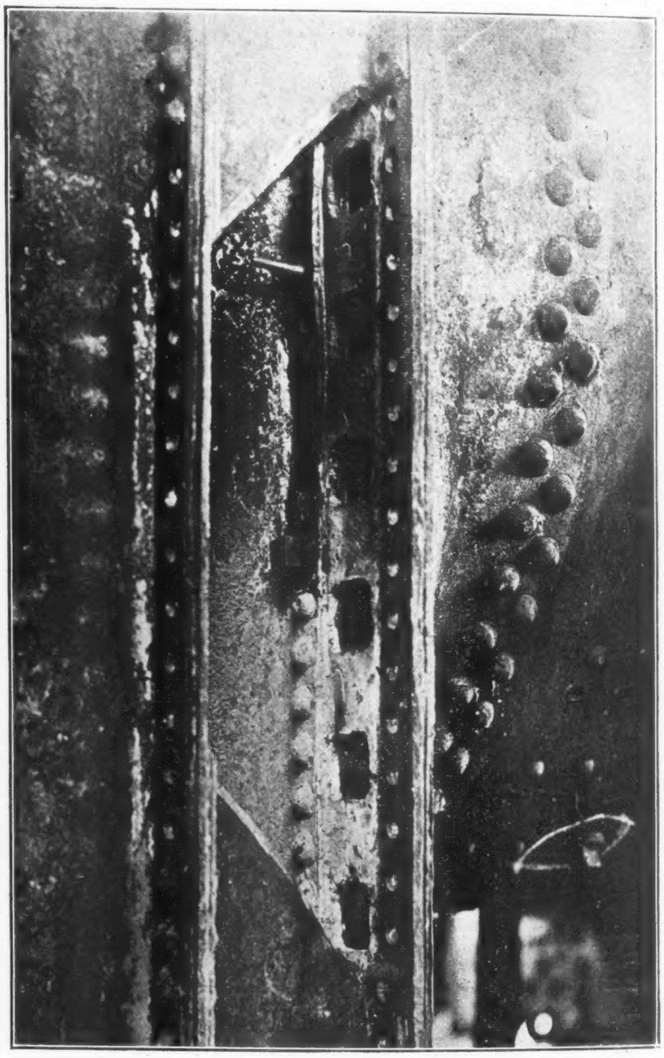


Fig. 4—A Method of Repairing Inside Sections

and sections will be in the same relative position as before. Next apply rivets to all of the inside sections, using an alligator riveter. Then fit up and reapply all outside sections in their proper place and rivet and caulk. The completed back end can then be reapplied to the boiler and the throat sheet connection riveted and caulked.

In laying out and punching any water circulation cut-outs in stay sheets, care must be exercised to have round corners, as square corners will crack out much sooner.

The Jacobs-Shupert firebox will accommodate itself to longitudinal strains due to the inequalities of the firebox and outside casing sheet expansion, but will not accommodate

itself to transverse strains from the same cause. Each section being of a semi-circular shape will take care of accumulated longitudinal expansion, but the transverse rigid stay sheets will permit of no equalization of the vertical or transverse stresses which occur, especially during the operation of firing up cold boilers. These strains and stresses first cause the inside sections of fireboxes to crack and as they develop further the strains are communicated to the transverse stay sheets, causing the cracks as shown in Fig. 2 where the stay sheets come in contact with the outside sections. These same stresses also cause cracks at the door sheet and flue sheet in the side water legs.

This style of firebox tends to travel upward in service, this being proved by the fact that it is necessary periodically to inspect the two center rows of sling stay straps in the crown section. On removal of these straps after the firebox has been in service it will be noted that it is a very difficult matter to remove the supporting bolts, due to compressive strain on the sling stay straps. Often, when replacing the same straps in the same position it is noted that they are from 1/32 in. to 5/64 in. too long, thereby necessitating the making of new straps. This compression, on the solid stays next to the center sling stays at the front end of the firebox at the flue sheet is enormous and being communicated to the outside sections is the cause of cracks in the outside sections, necessitating their removal, as shown in Fig. 3. In the writer's opinion the only way to prevent the cracking, and the resultant necessity of renewal of outside top sections, is to design the Jacobs-Shupert fireboxes with at least an 18 in. combustion chamber in front between the firebox and the tube sheet.

Scale will not accumulate to any great extent in the center of the firebox sections, due to their constant expansion and contraction. A heavy scale will collect on and adjacent to the rivet heads of the connection of the firebox sections to the stay sheets and this needs attention and should be frequently removed.

The tool shown in Fig. 5 used in connection with a small air hammer has proved very effective in removing this scale. This tool is passed rapidly over the fire side of the section along the stay sheet caulking edge, thus jarring loose the scale on the water side of the section. The cleaner the firebox sections are kept, the better the results will be and the cracking of the inside sections can be reduced somewhat by keeping the scale formation at a minimum.

The water and fuel conditions enter more largely into the question of sustained service of Jacobs-Shupert fireboxes than in the standard staybolt types. With good water, and coal as fuel, the Jacobs-Shupert firebox will give from two to three times the service of the standard staybolt type, but with oil as fuel and when operated in bad water districts, it will give only one-fourth the service of a firebox of the staybolt type.

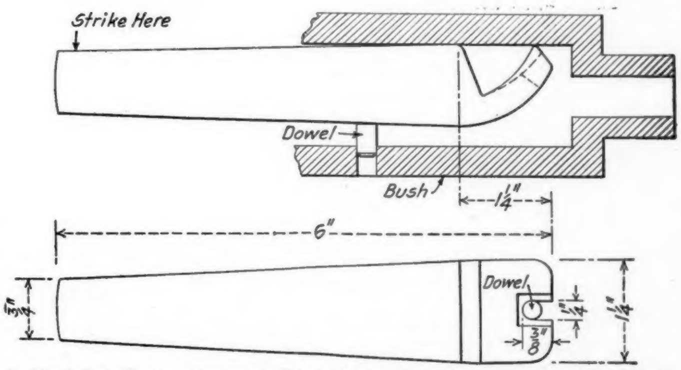
From a safety standpoint, the Jacobs-Shupert firebox is, at the present time, the most perfect form of locomotive firebox. Because of its sectional construction it is impossible to explode one of these boxes. The worst that has happened, in a number of instances, is the overheating and consequent stretching and the ultimate bursting of one of the crown sections.

Due to the fact that it is practically impossible to explode one of these fireboxes, enginemen handling them will sometimes run long distances with no water in sight in the glass. This practice causes crown sections to overheat and pressure stretches them to a semi-circular shape. In removing the flues at shoppings it is often found that in the second row from the top the flues are distorted and sometimes are collapsed from this cause. Particular care should be used in setting water glass and gage cocks on this type of firebox so that the maximum amount of steam space without the sacrifice of safety may be obtained.

REMOVING DOWEL FROM AIR PUMP REVERSING VALVE BUSHINGS

BY J. A. JESSON

In the article describing a method of repairing worn reversing valve bushings of 9½-in. air pumps, which appeared on page 210 of the April issue of the *Railway Mechanical Engineer,* no method for removing the dowel was shown. The accompanying sketch shows a single tool that will both extract and replace the dowel in a very simple manner. It consists practically of an elongated claw hammer without the handle hole. The claw is driven over the dowel, its



A Tool for Removing and Reapplying Dowels in Reversing Valve Bushings

sharp edges forming a grip in the soft metal; tapping the end of the tool pulls out the dowel in the same manner as pulling a nail.

To replace the dowel, start it in the hole, then place tool in position, as shown, and force the dowel in by striking the end of the tool. By this method all work is done from the inside of the bushing. The plug in the body need not be disturbed.

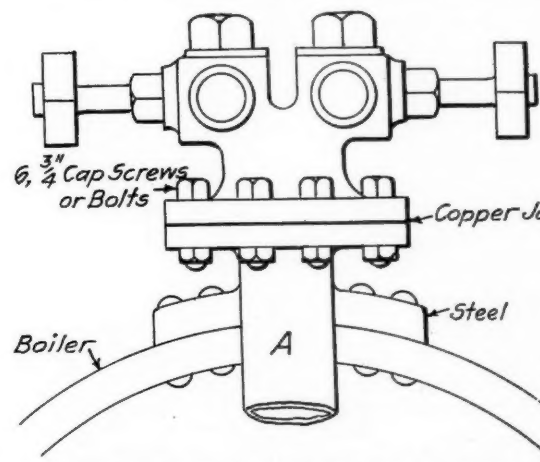
An old drill shank will make a good tool, care being taken to round off that part that bears against the bush while replacing the dowel.

A BOILER CHECK CASING WITH GASKET JOINT

BY J. H. HAHN

Night Machine Shop Foreman, Norfolk & Western Railway, Bluefield, W. Va.

The sketch shows an improved boiler check casing which was designed by the writer to overcome the trouble caused by the ordinary type of boiler check casing leaking at the



Boiler Check Casing With Special Fitting

joint where it is bolted to the boiler, as was the case with the older designs. Considerable trouble is often experienced

with the check casings that bolt to the boiler direct and use a ball joint ring, but with the type of check casing shown in the sketch there is little or no possibility of the casing leaking.

This boiler check casing is provided with a flanged joint and bolts on the special fitting *A*, which is riveted to the boiler shell. A gasket is placed between the flange and the fitting *A*, thus insuring a tight joint.

Any check casing of the ball joint ring type can be converted into the gasket type by simply adding one of the special fittings and bolting the check casing to it as shown. A slight change in the branch pipes may be necessary because the fitting *A* raises the check casing slightly higher than is necessary when it is connected to the boiler in the usual manner.

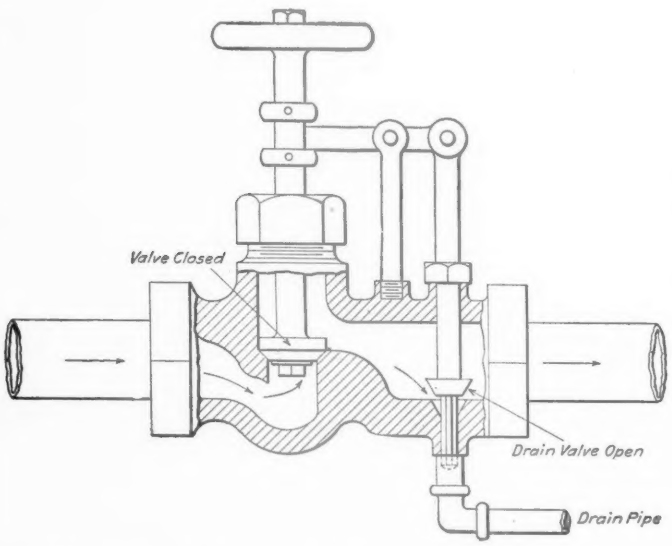
AUTOMATIC SELF-DRAINING GLOBE VALVE

BY J. H. HAHN
Night Machine Shop Foreman, Norfolk & Western Bluefield, W. Va.

The globe valve shown in the sketch was designed to eliminate the liability of damage to air pumps, stokers, electric turbines and generators, etc., due to freezing in the winter time. It prevents the accumulation of condensation in pipes where it is not desirable.

The valve is of the usual globe valve design with an automatic or self-operating drain valve attached. When the globe valve is closed the drain valve is opened, the collars on the globe valve stem engaging the lever as shown, which in turn operates the drain valve which is contained in the valve body. When the globe valve is opened the drain valve is closed in the same manner.

This self-draining valve will save much of the additional



Section through the Valve showing the location of the Automatic Drain

piping necessary in putting in tees and drain valves of various kinds that depend upon the human element for their operation. With one of these self-draining valves applied in the steam line to a cross-compound air pump, all the drain cocks that are now used to drain off the condensation could be dispensed with.

On cold nights in the winter when the locomotive is in the roundhouse dead the probability of the drain valve being left closed is great, but with this self-draining device danger of freezing is eliminated.

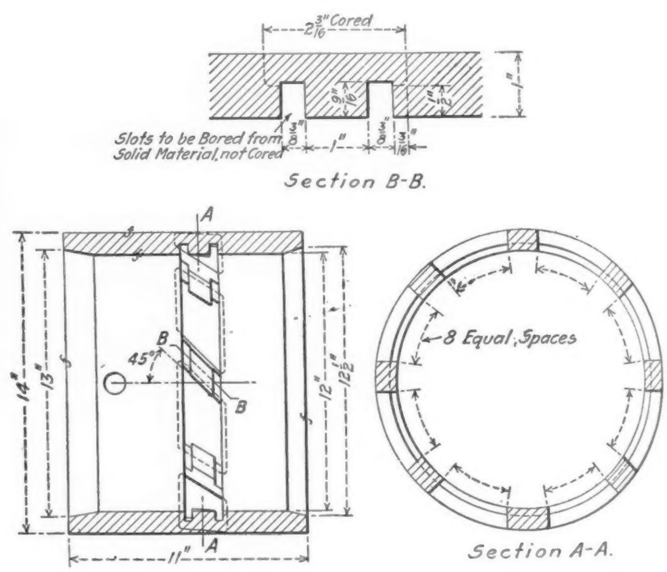
A SPECIAL VALVE BUSHING DESIGN

BY L. P. MICHAEL
Chief Draftsman, Chicago & North Western, Chicago

A valve bushing which the writer has had designed and which has been adopted as standard on the Chicago & North Western is shown in the drawing.

The special feature of this valve bushing is the method used in coring the steam port openings. These cored openings are made of such shape that the edges of the steam port can be finished in the boring mill or lathe at the same setting used for boring out the bushing.

This saves considerable time and labor, as the port edges are usually finished on either a milling machine or draw-cut shaper. The finishing of the port edges can be done in the lathe or boring mill by cutting a groove for each port edge. The groove is 3/8 in. wide and the packing ring is of tee



Method of Caring and Finishing the Ports

shape, 7/8 in. wide over the head of the tee, which gives a bearing of 1/2 in. when the ring is over the finished port groove.

A bushing of this design not only can be finished with less time and expense than the ordinary bushing, but it also gives the advantage of a considerably larger port opening, especially at short cut-offs.

HEAT VALUE OF FUELS.—Tests of the heating values of fuels have become of great commercial importance, as practically all coal sold on large contracts is paid for on the basis of the heating value found in the tests conducted by or for the purchaser. The instrument used for carrying out this test is the bomb calorimeter, which comprises a strong, steel cartridge or capsule with a removable cover, adapted to contain a small charge (about 1/30 ounce) of coal. The bomb is tightly closed and oxygen is introduced under high pressure. It is then put into a calorimeter, the coal ignited electrically, the heat generated being absorbed by the water. The quantity of heat liberated in the combustion of the fuel is then calculated from the rise in temperature of the water. Important aid has been given in the standardization of the testing of coal for calorific power by the issuance by the Bureau of Standards samples of materials of accurately known heat values which afford a simple, precise, and convenient means by which the user of the calorimeter may check up the accuracy of his own determinations.—*Technical News Bulletin, Bureau of Standards.*

MODERN HIGH SPEED TOOL STEEL*

The Origin and Development of Modern High Speed Steel; The Hardening and Tempering Qualities

BY JOHN A. MATHEWS

AFTER accepting the invitation of the Committee on Papers and Publications to present a paper on the announced subject, the writer began to wonder just what the Committee meant by "Modern" High Speed Steel. A product that is of less than twenty years' standing is certainly modern when compared with crucible tool steel which has been manufactured for about 170 years, and even the air-hardening steels which preceded high speed steel resulted from the investigations of R. F. Mushet about fifty years ago.

I have been deeply interested in everything pertaining to the history of the iron and steel business, but this latest product, high speed steel, seems to have sprung fairly fully developed from a variety of sources and at almost the same time, and I have been unable to show just when the change from the old type of air-hardening steels to the modern type of high speed steels took place. Obviously the change is associated with the announcement of the Taylor-White process; that is, the high heat treatment given these grades of steels as compared with the ordinary treatment of carbon tool steels. This process was announced at the close of the nineteenth century, and the results of the Taylor-White process were demonstrated on a large scale at the Paris Exposition in 1900.

Notwithstanding the fact that the originators of this process took special trouble to disclaim the invention of a steel, but only a process for treating steel, a large number of workers in steel still seem to feel that they were the inventors of the product known as "High Speed Steel." Mr. Taylor, in his epoch-making paper on the "Art of Cutting Metals," very plainly states that this was not the case, and most users of steel have forgotten that the type of steel to which this treatment was first applied was the high-carbon air-hardening steel used prior to 1900.

The change from air-hardening to high speed steels was rather a matter of evolution than a distinct invention, and I have not been able to ascertain that the change was the result of any one man's discovery or invention. Chemically the change consisted in a very radical lowering of the carbon content and a great increase in the tungsten or molybdenum content. The chromium percentages have not been materially altered as compared with previously existing air-hardening steels; but high manganese, which was an important constituent of the original Mushet steel, is not now an important constituent in high speed steel; in fact, chromium replaced manganese in most of the air-hardening steels during the later years of their use in the nineties.

In 1901 the writer collected a number of the typical analyses of air or self-hardening steels from large users of these products. In 1902 our analyses showed that the change had already taken place in America, England and Germany, and the contrast is illustrated in Tables I and II. Each table contains products of the three countries mentioned, but the exact maker is not designated.

The high carbon content and the low tungsten or molybdenum content in Table I indicates the character of air-hardening steels in use prior to 1901.

In Table II, although these analyses were made only one year later, it is seen that a change in character has come about, and relatively low carbon, with high tungsten or molybdenum, is the characteristic feature of the new steels. It will be noted that two of the steels in Table II, one a molybdenum and the other a tungsten steel, contain no chromium.

It should be borne in mind that during the later days of air-hardening steels and the earlier days of high speed steels, it was a difficult matter to produce low carbons with the available ferro-alloys. The introduction of electric furnace and alumino-thermic alloys had much to do with the success of manufacturers in keeping their carbons down, but the idea that they should be reduced and that the alloys might be increased in conjunction with the application of a high heat treatment seems to have been almost spontaneous with the makers of tool steel in every country. In my search for the definite origin of this idea I learned of a user of steel who in the early days of the Taylor-White process obtained some extraordinary results with a particular bar of the old Sanderson self-hardening steel. Upon analysis it developed that this particular bar was considerably lower in carbon than usual, and instead of reporting this fact to the maker, he gave a sample of the steel to the representative of a foreign mill.

TABLE I—SELF-HARDENING STEELS, 1901

Maker No.	Carbon, per cent	Manganese, per cent	Chromium, per cent	Tungsten, per cent	Molybdenum, per cent
1	2.19	1.32	0.50	5.63	....
2	1.69	0.45	3.73	7.63	....
3	1.14	0.33	2.09	7.98	....
4	1.79	0.50	3.96	....	4.54
5	1.55	0.24	3.22	7.80	....
6	1.55	0.21	3.67	9.42	1.10
7	1.78	1.18	....	7.22	....
8	1.40	1.65	3.69	....	4.59
9	1.75	3.92	....	6.61	....

TABLE II—HIGH SPEED STEELS, 1902

Maker No.	Carbon, per cent	Manganese, per cent	Chromium, per cent	Tungsten, per cent	Molybdenum, per cent
21	0.63	....	4.00	....	6.00
22	0.42	....	4.95	10.75	....
23	0.57	0.43	3.30	11.58	....
24	0.75	....	....	19.50	....
25	0.37	....	5.10	13.83	....
26	0.62	....	6.50	21.06	....
27	0.84	0.07	2.76	11.25	....
28	0.56	....	2.95	9.74	....
29	0.60	0.30	....	....	9.25

My former associate at the Sanderson Works, Dr. E. L. French, is on record, however, as having predicted prior to 1900 that the tendency would be to rely for hardening upon tungsten and chromium rather than upon carbon in order to secure the kind of hardness which resists tempering—in other words, the peculiar red hardness upon which high speed steels depend.

It is probable that we shall never know who took the radical step and made the first low-carbon, high-tungsten high speed steel, but immediately following the announcement of the Taylor-White process there was great activity on the part of all tool steel makers in every country to produce a product which would yield maximum results when treated by this process. The courts decided that Messrs. Taylor and White did not make a patentable invention or discovery. A world jury, however, seemed to differ with this decision and every scientific honor was awarded them for their epoch-making announcement which revolutionized machine-shop operation and machine-tool building.

With the development of high speed steels there has been much study devoted to them from many angles. The engineer, the machinist, the chemist and the metallurgist have all been interested, and much has been said and written in regard to

*A paper presented at the Twenty-second Annual Meeting of the American Society for Testing Materials, held at Atlantic City, N. J., June 24-27, 1919.

this remarkable product. The question to be answered by all investigators of high speed steels has been: What constitutes the most efficient cutting tool and why? In Mr. Taylor's work "The Art of Cutting Metals," the point of view of the machine-shop economist is most ably presented. His work records the development of a high speed tool in regard to its composition, its heat treatment and the method used to secure the most economical removal of metal. The peculiar property of these steels in resisting softening in use Mr. Taylor has called the "quality of red hardness," and he makes no attempt to connect red hardness with any of the previously known physical properties of metal. The only method of measuring this quality of red hardness known to Mr. Taylor was the very expensive and time-consuming resort to cutting tests. The necessity for shorter and more easily applied tests was appreciated by Mr. Taylor, for he says, referring to cutting tests: "This test requires so much expensive apparatus, consumes so much time and is so slow, that a simpler index or guide which will indicate correctly the quality of high speed tools is much needed. Moreover, we firmly believe that in time some simpler index to the property of red hardness in tools will be found."

Accepting this suggestion, many able scientists have conducted investigations upon the hardening and tempering qualities of high speed steels of many compositions, and also in connection with the study of the specific functions of the various elements entering into their composition. I might mention specifically the work of Dr. H. C. H. Carpenter upon the types of steel and critical ranges of heating and cooling of high speed steels under varying thermal treatment, and also upon the tempering and cutting tests of high speed steels. The writer took a special interest in these investigations because of the fact that he had the pleasure of furnishing Dr. Carpenter many of the alloys used by him, taken from materials used in his early investigations in this country.

It may be taken for granted that any one interested in the scientific study of high speed steel will study Mr. Frederick W. Taylor's work upon the art of cutting metals. Dr. C. A. Edwards has studied the function of chromium and tungsten in high speed steels, and in conjunction with Mr. H. Kikkawa, published a later paper upon the effect of chronium and tungsten upon the hardening and tempering of high speed tool steel. Particular attention should also be given to the papers by Prof. J. O. Arnold and A. A. Read upon the chemical and mechanical relations of iron and carbon when associated with tungsten, molybdenum, chronium and vanadium. Each of these elements has been taken up one at a time in its relation with iron and carbon.

Dr. Carpenter, in studying the heating and cooling curves of tungsten and molybdenum products, finds the effect of these elements to be, first, the widening, splitting and lowering of the critical ranges by the special alloy elements; second, the complete suppression of the widened, split and lowered range by rapid quenching. He found also that these steels so hardened were in the austenitic condition and showed no signs of tempering when reheated below 500° C. and in some cases to even higher temperatures. Carbon steels show the effects of tempering as low as 200° C. Dr. Carpenter later supplemented this investigation with another one in which he studied the effect of etching reagents upon hardened and tempered high speed steels as prepared for microscopic examination. In general he found that the higher the steel had been heated for hardening, the less slowly it was attacked by the etching reagent. Also that when fully hardened and later subjected to tempering operations, the converse was true, namely that the more fully the temper had been drawn the more easily it was attacked by the etching material.

Dr. Edwards, in his earlier paper, finds that hardness assists the efficiency of the cutting tool, referring to purely mineralogical hardness as distinguished from red hardness. He also states that chromium forms a double carbide with the tungsten and a new brittle constituent appears at about 700° C. in tempering which caused the failure of high speed tools. In his later statement, published jointly with Mr. Kikkawa, he abandons these last two positions but states that chromium in these steels in conjunction with carbon is the cause of the great hardness of high speed steels and that it produces a marked lowering in the temperature at which hardness can be effected. He differs with the earlier conclusions of Dr. Carpenter that chromium does not confer the quality of air hardening in the absence of tungsten or molybdenum, but that chromium steel so hardened in air develops a comparatively slight degree of secondary hardening or "red hardness," as Taylor designated it.

In regard to high tungsten steel in the absence of chromium, he finds that a large proportion of the tungsten remains undissolved even when the temperature is raised to the melting point, and agrees with Arnold and Read that this tungsten is probably in the form of a tungsten iron compound, Fe_2W. Very rapid quenching from high temperatures results in much less hardening than is obtained from a high chromium steel similarly treated; but the tungsten steel, on tempering, undergoes a very pronounced secondary hardening—in other words, it is the tungsten which confers the quality of red hardness. While Dr. Edwards, in his investigation, did not cover a study of molybdenum, we can say that molybdenum in its effects is very closely analogous to tungsten and about twice as efficient; that is, an amount of molybdenum confers a degree of red hardness similar to or greater than twice its weight of tungsten. The difference between these two metals seems to be one of degree rather than of kind. When chromium and tungsten are present together the presence of the chromium increases the solubility of the tungsten when raised to high temperatures. Dr. Edwards states that the maximum of resistance to tempering and the greatest degree of secondary or red hardness is obtained by getting the tungsten into complete solution, and in modern high speed steels he places this temperature at about 1350° C. (2462° F.). In our experience this temperature is too high for practical results and is apt to result in brittleness, and also, as will be shown later, the hardness seems to decrease rather than increase upon extreme over-heating to such a temperature, and at this temperature there is formed a so-called "brittle constituent," to which Dr. Edwards refers in his first paper. This constituent is due solely to over-heating and is not produced when tempering at 700° C. (1392° F.) in properly hardened high speed steel.

Dr. Edwards also points out very clearly, and shows by his results, that this secondary hardness by drawing the temper may be and usually is actually greater than the initial hardness of the hardened high speed before the temper has been drawn at all, but that at intermediate drawing temperatures there is some lowering of the hardness, which later increases as we approach the temperature at which full annealing begins. The temperature at which he finds the maximum secondary red hardness coincides almost exactly with the temperature given by Taylor as that recommended for the second heat treatment required in the Taylor-White process, for, as described by Mr. Taylor himself, the second heating of the hardened tool consists of heating the tools "(*a*) to a temperature below 671° C. (1240° F.), preferably to 621° C. (1150° F.) for about five minutes; (*b*) cooling to the temperature of the air either rapidly or slowly."

As previously reported to this Society, in a paper entitled "Magnetic Habits of Alloy Steels," the writer began some fifteen years ago to study systematically, and as a matter of routine, the magnetic properties of practically all the alloy steels manufactured in our regular line of business. That paper did not touch upon any magnetic work in conjunction

with air-hardening or high speed steels, but such work was commenced in the earliest days of the modern high speed steel, and renewed attention was given to this matter after the suggestion of Mr. Taylor that a simpler index or guide to the quality of high speed steels would be of great use and importance. A paper on the subject of the physical characteristics of high speed steel was promised for presentation at the last meeting of the International Association for Testing Materials held in New York in 1912. At that time the work was not sufficiently advanced to permit of presenting the results, and, in fact, even yet the results are not what we had hoped to obtain from this long continued study. It was thought that there might be found some critical temperatures in connection with the magnetic or electrical resistance of high speed steel which would furnish a definite indication of its properties at those temperatures most suitable for commercial hardening. In addition to magnetic and resistance tests of various high speed steels hardened and tempered in a wide variety of ways, we have supplemented the work with microscopic examinations, and to some extent by cutting tests.

While in the aggregate a great variety of high speed steel compositions have been tested, not only of our own regular and experimental steels, but also commercial steels of a great many brands foreign and domestic, the greater part of the systematic investigation was confined to four steels, the analyses of which are given in Table III. These steels cover quite a range as regards their chromium, tungsten and vanadium content. Steel No. 31 represents a type which was fairly generally used about ten years ago; in fact, various writers as the result of practical tests, have contended that tungsten above 13 or 14 per cent is of no advantage. Practical experience, however, has led for the most part to higher tungsten percentages.

Steel No. 34 is introduced because it corresponds quite nearly with the analysis of steel to which Mr. Taylor referred as giving the best results obtained with any steel at the time he was actively engaged in this work. In fact, because of Mr. Taylor's recommendation, steel of this character was once adopted as the standard material desired by the Navy. Their specification, however, calling for high tungsten and high chromium, was abandoned after one year because it was found that steel of the type represented by No. 33 gave materially better results.

Steel No. 32 is intermediate in quality as compared with Nos. 31 and 33. As the result of a very exhaustive series of cutting tests made as nearly as possible in accordance with the methods outlined and recommended by Mr. Taylor, these four steels will rank about as follows, starting with No. 33 as 100 per cent efficient: Steel No. 34 would be represented by 70 per cent, No. 32 by 66 per cent and No. 31 by 45 per cent.

Table III—Analyses of Four Steels Used in Tests

Steel No.	Carbon, per cent	Silicon, per cent	Manganese, per cent	Chromium, per cent	Tungsten, per cent	Vanadium, per cent
31	0.63	0.19	0.26	4.21	13.10	0.25
32	0.61	0.19	0.36	3.34	16.28	0.40
33	0.63	0 27	0.31	2.99	16.87	0.85
34	0.64	0.22	0.24	5.35	18.99	0.15

It is apparent, therefore, not only from the analyses but from the figures above, that the steels are typical of well-known commercial types of steels, and it therefore might be thought that their behavior electrically and magnetically, also as to hardness, would show marked differences, with possibly some differences in critical temperatures both in hardening and in drawing. However, this does not appear to be the case, but the following general conclusions can be stated in regard to all of them.

Starting with hardening temperatures at 982° C. (1800° F.) and carrying them up to 1315° C. (2400° F.), it would be noted that the electrical resistance, the scleroscope hardness and the coercive force increase fairly uniformly with the hardening temperature up to about 1260° C. (2300° F.). There is a slight tendency to show a reversal of these properties beyond this temperature. In other words, it would indicate that overheating had commenced. Magnetic induction and residual density, as the hardening temperature increases, are lowered.

If these steels hardened at proper temperatures to develop full austenitic structure are subjected to the tempering operation varying from room temperature up to 649° C. (1200° F.), it is noted that there is a general falling off in the hardness, resistance and coercive force as the drawing temperature is increased. This is not quite in accord with statements that have been made that there is no effect in drawing the temper of high speed steel until the temperature of 500° C. (932° F.) has been reached. It is true, however, that the effect upon these properties is only slightly influenced below this temperature, while the rate of change increases fairly rapidly at temperatures above 482° C. (900° F.). There is no indication, as regards magnetic properties, of anything corresponding to the secondary hardening referred to by Edwards, nor have we found it in connection with hardness tests made by the scleroscope. In cases where the Brinell method is used we found it very difficult to get constant results with materials so extremely hard, but with that method we have found an indication of re-hardening, or secondary hardening at high drawing temperatures, the maximum usually being at about 593° C. (1100° F.). The lower the temperature at which the initial hardening is done the lower will be the temperature at which the re-hardening occurs on tempering, and presumably the sooner a tool so treated would fail in severe cutting where the frictional temperature was high. When the temperature in cutting is not extremely high we cannot conclude that the steel would fail sooner than one with a higher re-hardening temperature. In such cases, in my opinion, physical or mineralogical hardness plays an important part as distinguished from red hardness, but where the cutting conditions are severe it would appear logical that the higher the temperature of red hardening the longer the endurance of the tools.

The tests that we have made were for the most part made upon hot rolled 1-in. by ⅝-in. bars in just the condition that might have been used for cutting tests or for supplying to users. After all heat treatments, however, the surface was examined by file testing to see that no unreasonable decarbonization had taken place. There was, however, some slight decarbonization of surface in all cases, undoubtedly due to scale and oxidation. However, we wished to operate under conditions as nearly as possible those that would obtain in practical work in case it were found possible to make use of physical tests rather than cutting tests as a means of judging the relative merits of high speed steels. Of course for determining hardness it is necessary to remove, by grinding, sufficient material to get below any possible decarbonized or oxidized zone.

We are convinced that to make these tests with scientific accuracy would require conditions of heating and temperature control much more refined than are usually found in industrial plants and that it would be desirable to operate on round pieces which could readily be rough turned prior to any treatment and ground on centers after each treatment to insure making the test on perfectly sound material. This, in my judgment, removes such methods from the kind of tests that Mr. Taylor had in mind, as they introduce the same element of expense and require the expenditure of considerable time.

For purely scientific reasons it might be worth while to conduct such a series of tests on different types of high speed steel; the intervals of temperature should preferably be not over 10° C. (50° F.) both in the tests made on hardened bars

and also on the tempering ranges, particularly from, say, 482° C. (900° F.) up to the point of softening. This is entirely too complicated and extensive a program to consider as a convenient substitute for the cutting tests.

To refer again to the title of the paper and what is meant by "Modern," we might call attention to the difference in analyses displayed in Tables II and III. The most noteworthy change is in the introduction of vanadium, which is now used in practically every high speed steel; in fact, it is the only general addition that has been made to the earlier types which seems to afford universal improvement in quality. The writer began experimenting with the use of vanadium in 1903, and it is well to bear in mind that at that time vanadium was almost a chemical curiosity. It was worth about $15.00 a pound, and this was some time prior to the formation of the American Vanadium Co. which manufactured and sold vanadium in large quantities. So far as the writer is aware, the entire stock of ferro-vanadium in the country when these experiments were begun consisted of not over 100 lb. in the hands of two different dealers in New York. We purchased one-half of the entire stock of each dealer. As the result of these experiments carried on at the old Sanderson Works, a patent was granted the writer, issued on January 3, 1905. Other experimenters were doubtless working with the same thing, and, in fact Mr. Gledhill referred to its use in 1904, as did also Mr. Taylor. In fact, the composition of tool steel previously referred to as giving Mr. Taylor his best results, showed 0.3 per cent of vanadium. During the year 1905 the Rex AA steel was put upon the market, and other vanadium steels followed shortly, but it was not until three years later that certain foreign makers copied this original steel exactly and made great claims as to originality in regard to their product.

As has been stated, vanadium seems to have conferred general benefit upon all tungsten-chrome or molybdenum-chrome high speed steels. In this particular it differs from other additions that have been introduced since. The use of cobalt received considerable attention a few years ago, but it was noted that it was always present as an addition to types of steels that would have given remarkably good results if the cobalt had been omitted. I have never seen anything to indicate that it could be used as a substitute for any of the other elements regularly present, and its use is not now as extensive as it was a few years ago. As an element of increased cost it has not shown sufficient improvement in the long run to warrant its general use. So far as our observations are concerned it seems to lead to some uncertainty in the manufacture and treatment of the steel, and steels containing it seem to be more difficult to re-forge or re-dress than steels in which it is absent. These comments are made notwithstanding the fact that one of the most carefully conducted competitive tests on high speed steel ever made in an industrial plant was won by a steel containing cobalt, and it might be added that there is every probability that the same steel without the introduction of cobalt would have been equally as successful.

The use of uranium has been advocated during the past few years, but it seems to be very difficult to handle owing to the ease with which it is oxidized, and so far as our experience goes we have been unable to see that it confers any specific benefit. Such steel as we have examined has been more apt to show seams and surface defects than steel in which it is absent, and the microstructure of the steel itself usually indicates the presence of considerable amounts of material that are suspected of being oxides of uranium. It should be noted that when oxide of uranium is formed in melting it has small chance of being eliminated in the slag owing to its great weight. It may be that with more experience means will be found of introducing this material into the bath without such great loss of expensive metal and without the formation of these impurities in the steel which cannot but prove detrimental.

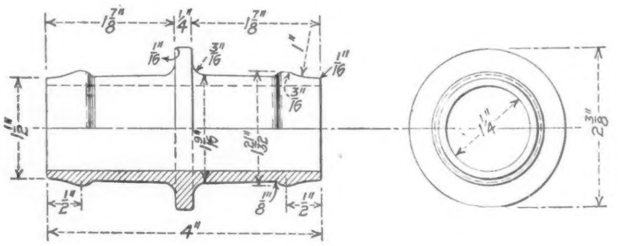
Other elements have been tried, including cerium and zirconium, but no conclusions are available as yet.

The term "Modern" High Speed Steel therefore may be considered as referring to the product since the introduction of vanadium, as no generally accepted improvement has been made in high speed steel since that time. Improvements have resulted in the general quality of the material available, due to greater skill in manufacture, and to the availability of superior raw materials in the form of metals and ferro-alloys than were obtainable in the early days of the industry. It is still a constant source of surprise to see tests conducted in which a steel that may appear of inferior analysis proves successful, whereas some other type of analysis, judged from this viewpoint only, would naturally be expected to prove the better steel. In a very elaborate series of tests, including over 50 analyses, it was noted that in those steels included in the first group as to merit the compositions vary from 12.70 to 18.59 per cent of tungsten, from 1.70 to 5.58 per cent of chromium, from 0.40 to 1.73 per cent of vanadium, and from 0.52 to 0.81 per cent of carbon. The steels rated as second and third class in general covered almost identical ranges. It therefore seems that steel making rather than chemical analysis is the first consideration, and so far we are not able to define or to specify all the elements which enter in, from the melting to the finishing of a bar, to produce first-class material in a very wide range of analyses, and no physical or chemical test has as yet been developed which helps very much in determining the matter of quality.

RECLAIMING AIR BRAKE HOSE

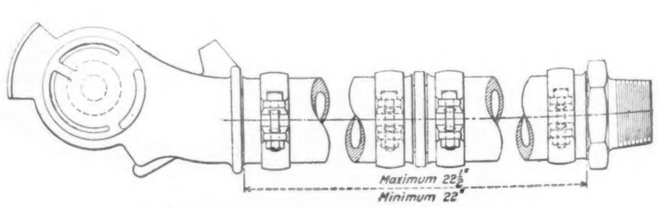
BY E. A. M.

A method of reclaiming air brake hose which is efficient and economical is illustrated in the drawings. Hose which has been cut, chafed, burst or otherwise damaged but in



Special Nipple for Splicing Hose

good condition for at least one-half its length can be reclaimed by splicing the undamaged portions as shown in the drawing. Two pieces of hose cut to the proper length



Spliced Hose with Fittings Applied

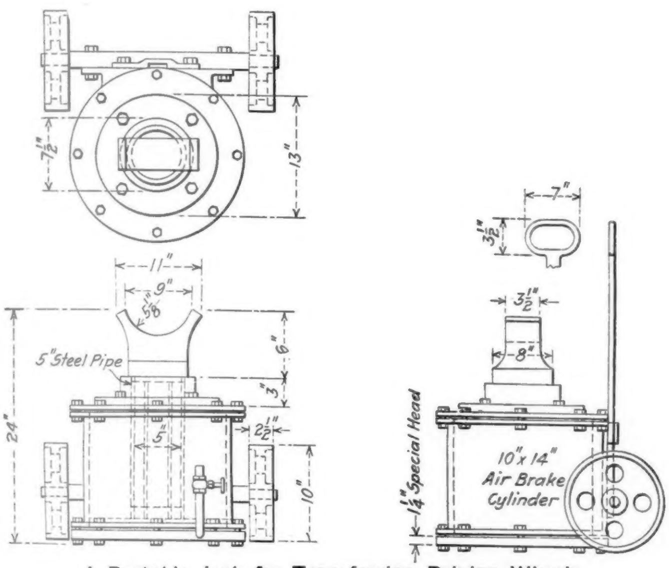
are clamped to a nipple and the fittings applied at the ends of the spliced hose in the usual manner.

The reclaimed hose may be applied to the front end of road engines, both ends of yard engines, caboose, camp and maintenance of way cars.

AIR JACK FOR LIFTING WHEELS

BY C. W. SCHANE

The air jack shown in the drawing provides a convenient means of transferring driving wheels about the shop. The jack consists of a standard 10-in. by 14-in. air cylinder with a special head applied at the bottom so that an air pipe can be connected to the jack. The top is machined off and a guide bolted on. The standard is of five-inch steel pipe with a holder so designed that the pipe and cylinder plunger or piston rod are always in line and act as a pivot. Small wheels, similar to those used on hand trucks, are applied to one side of the jack and a socket is provided for a removable handle by means of which the jack may be moved from place to place.



A Portable Jack for Transferring Driving Wheels

To transfer a pair of wheels from one track to another the jack is placed underneath the axle with the holder at the center and air from the shop line admitted into the cylinder at the bottom. This raises the plunger, thus lifting the wheels clear of the rails. They are then turned in the desired direction on the pivoted holder, the air pressure in the cylinder relieved, the wheels lowered to the floor, and the jack removed. The wheels may then be rolled to another track, the handle inserted in the socket and the jack moved in position to again raise and turn the wheels as may be desired.

BENDING STIRRUP BRAKE HANGERS IN A BULLDOZER

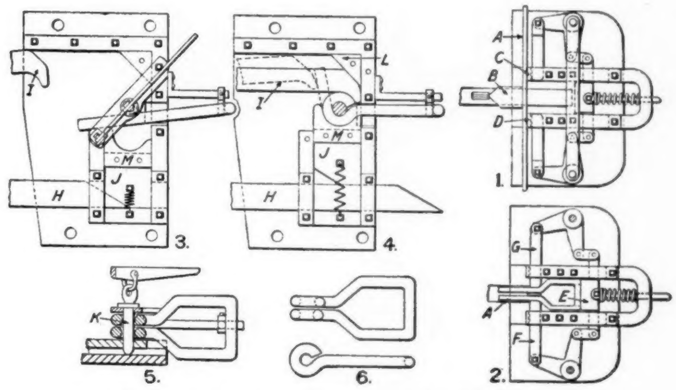
BY B. S. LYON

Blacksmith Foreman, C. B. & Q., Galesburg, Ill.

An attachment to a bulldozer for bending two eyes simultaneously has given very satisfactory results.

A piece *A* of 1-in. round stock of the required length is heated and placed in the position shown, Fig. 1, where *B*, advancing, binds *A* between *C* and *D*. As *B* continues to advance, the piece comes in contact with *E*, the movement of which compresses the spring and by the movement of two bell cranks operating *F* and *G* bends *A* as shown in Fig. 2. This completes the first operation.

The partly formed brake hanger is now reheated and inserted in a form for bending the eyes, as shown in Fig. 3. The two plungers, *H* and *I*, advance simultaneously, *H* pushing *J* and *M* forward, bending *A* as shown by dotted lines in Fig. 4. *I* then engages *A* and bends it around the pin *K* with a lateral motion imparted by *L*. This forms the eyes and completes the hanger as shown in Fig. 6. Fig. 5 shows the method of withdrawing the pin *K* from the eyes by the use of a lever and clevis.



The Attachment In Place on the Bulldozer

The two pieces *L* and *M* are removable so that other parts may be bent by substituting forms of the desired shape in place of those shown in the drawing.

ESSENTIAL FACTORS IN PROMOTING SHOP OUTPUT

BY GEORGE W. ARMSTRONG

The past eight months have witnessed a radical change in the operation of many large railroad shops through the elimination of piece work. However drastic the transition may seem to many, it should not present an insurmountable barrier to retaining a high degree of shop efficiency and in some instances of improving the quality of the output. The essential factors for the most successful shop operation, as stated by the writer in a previous article,* are not inherently different for the day-work system than for the piece-work system. The stressing of latent or neglected factors is, however, required adequately to meet the changed conditions. A brief exposition of some of these essential factors was embodied in the recommendations of a committee which recently investigated shop record and management conditions in the Eastern Region.†

First and foremost, the results attained are dependent upon the supervision, the existing degree of co-operation, attentive interest and responsiveness; in other words, an effective organization. Without co-operation and harmonious efforts of supervision and working force, the efforts of the best organization conceivable are nullified.

By sheer force and driving work may be put through a shop, but unless good feeling exists between the helper, mechanic, foreman, and shop superintendent the maximum output can never be attained. Harmony is the oil that overcomes friction—and yet harmony must not be secured at the expense of discipline, or abandoning the shop to the men in order to avoid possible labor complications. Firmness tempered with justice must be the prevailing sentiment.

The one question of justice has been the rock upon which many an organization has split. What is your idea of justice? What is the workman's idea of justice? How close does yours coincide with his? Do you make any effort to conform your ideas of management, discipline, etc., to the workman's views? Too often the actuating motive of organized labor effort has been the rankling idea that the workman was not receiving justice. Why not obviate possibility of distrust and implications of injustice by according labor a reasonable voice in local management?

Industry embodies two factors, capital and labor. Capital

*See the *Railway Mechanical Engineer* for June, 1918, page 341.
†See the *Railway Mechanical Engineer* for May, 1919, page 263.

has its representation in the business in expression through its directorate, staff officers and local supervision. Labor is restricted to its voice in collective bargaining.

Is it too much to accord labor a limited voice in the consideration of local management? Why not organize a workmen's shop committee as a portion of the shop superintendent's cabinet? The shop committee keeps the local supervisory head apprised of individual or collective grievances. But a shop committee dominated by the head of the shop is no good either to the working personnel or the employer. The manifestation of a sincere desire to insure justice, it is not unreasonable to suppose, may meet with a like response.

Unquestionably, for effective results, most shops have exhibited a dearth of supervision. The Eastern Regional committee's recommendation of one supervisor to 30 men is a maximum limit, especially for erecting or boiler shop work.

A shop scheduling system is absolutely necessary to secure expedited and co-ordinated movement of parts requiring replacement or repairs and prompt overhauling of equipment. Aside from its wholesome effect in this respect, it is an excellent indicator of the essential degree of co-operation existing in the organization and will do much to bring the laggard into line. Scheduling and routing material relieves the individual foreman of chasing material, thus affording greater opportunity for effective supervision of work.

The Eastern Regional committee report says:

"Experience shows that any system of despatching or scheduling of work through the shop must be predicated upon (1) a predetermined route; (2) a predetermined time."

The predetermined route or path over which the locomotive parts must travel is a fixed element depending upon the relation of various shop departments, sources of raw material storage, and location of machine tools within department bounds. While fixed, many improvements are not necessarily precluded. As far as possible changes should be made which will insure (1) straight line movement, and (2) balanced material trucking. Inasmuch as fixed routes which do not embody these requirements can exert a very retarding effect on scheduling, every effort should be made to study the routing thoroughly and effect all possible improvements before finally establishing a scheduling system.

Scheduling of necessity implies a despatching or scheduling supervisor. It requires a knowledge as to repair demands and a time limit. Knowledge of repair demands to be effective of the greatest good should not be confined to inspection upon arrival at the shop but supplemented by thorough advance information as to repairs required. Especially important is the knowledge as to whether new cylinders, wheel centers, driving boxes, fire boxes, extensive boiler repairs or heavy machine details are required. Properly used this information will enable the shop to prepare a greater portion of this material, or at least insure its availability in stock, so that when the engine is finally received it will involve removing defective portions and replacing these with new parts, while repairs are being made to minor details of construction, thus involving a minimum of idle time for repairs.

A predetermined time limit, to be a stimulus for bettered shop operation should be an attainable one, but yet one not reached without diligent effort. Nothing will be more detrimental to the successful use of a scheduling system than a repeated failure to meet the schedule.

In establishing suitable forms for a scheduling system too much detail is to be avoided, but essential information should not be sacrificed to secure brevity or conciseness. While it may be true that forms or reports never effect results, it is also true that the absence of proper reports permits the formation of many unguarded loop-holes and delays occur which are difficult of discovery. Forms convey standards, standards measure results and failures to secure results indicate points for investigation. How long would the business man dodge the sheriff if he did not keep a set of books? His books consolidate and provide control of the details of his business and the results lie in the details.

Scheduling requires inspection as the preliminary basis. Why not, then, enlarge the scope of inspection? A chief inspector reporting to the shop superintendent, with one or more assistants as may be necessary, can become one of the most powerful factors possible in insuring of quality workmanship. Such an inspection force can become thoroughly familiar with the standard maintenance practices, improvements ordered, etc., being charged solely with inspection duties. The subordinate supervision is thus relieved of these matters, leaving them free to devote themselves to departmental output, executive direction and discipline.

Unusual removals of material in stripping an engine should require the authorization of the inspection force and the decision as to repair or renewal of parts should be delegated to it. Miscellaneous small material could be inspected near the lye vat before delivery to respective departments for repair. If possible, material needed for replacement or repairs should be delivered with the dismantled material to the department overhauling it.

Material handling offers one of the greatest opportunities for improvement. Common labor is scarce, expensive and in the main always more or less inefficient. Mechanical facilities should be employed to the fullest extent. While in a good many shops overhead cranes assist in handling material from machine to machine or department to department, still considerable hand trucking is necessary. A reduction could be effected not only in cost of handling, but in size of force required by providing floors and walks smooth enough to operate electric trucks, preferably those embodying an elevating feature so that work is delivered to machine on a portable platform, removed from it to the machine, replaced by the machine operator and requiring simply to be lifted by the motor truck and readily transported to any point in the shop.

Why not employ an automobile truck with wide-rimmed wheels, for intershop material handling, providing wide doors in shops and roundhouses through which this truck could be run with its load of material and unloaded directly in the shop? This would eliminate much secondary handling.

Another feature of the material question which should be investigated is the possibility of securing material from the storehouse for use at various points in the shop without the necessity of men leaving their work to go to the storehouse. This can be secured by reasonable anticipation of wants and the installation of a messenger system which can be developed in connection with motor truck operation.

Orders for material may be left at different points in the shop, collected hourly and material delivered by motor despatch to the place required. This would eliminate a large loss in connection with the average shop operation in waste through loafing to and from shop and storehouse.

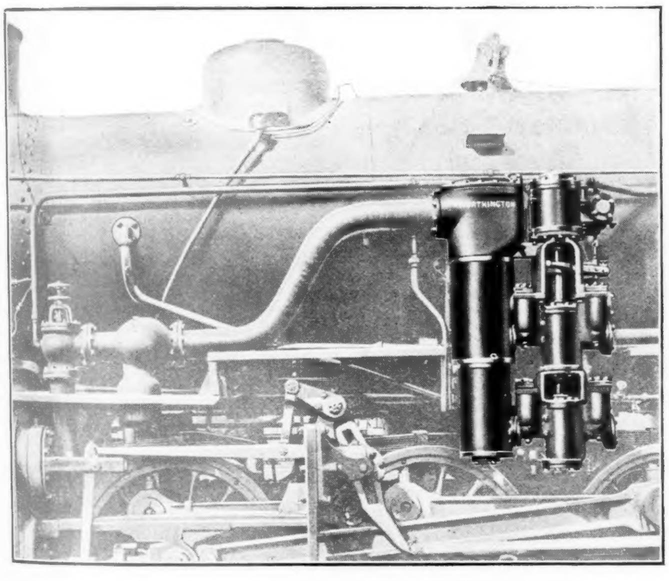
Miscellaneous small materials as bolts, nuts, washers, cotters, etc., could be placed in one or more accessible points in the shop and charged out in bulk through shop expense when delivered by the storehouse. This would reduce often needless delay and it is believed would be productive of ultimate economy in the use of materials.

An intercommunicating telephone, with a call system, placed through the shop so as to provide a phone every 100 or 150 feet would prove a large time saver and be productive of a great intangible economy. It could be effectively employed in conjunction with a material messenger delivery. Material could be ordered by the inspector or foreman, charged out by the storehouse office on a material blotter and delivered by the messenger. This would eliminate the written order and place the responsibility with the Stores Department for charging out material as well as delivery.

NEW DEVICES

AN OPEN TYPE LOCOMOTIVE FEED-WATER HEATER

The Worthington Pump & Machinery Corporation, New York, has developed and has in service on several Mikado type locomotives a combined feed pump and feedwater heater, which follows closely their marine practice. This heater is of the open type, which is now generally used in stationary power plants and is capable of handling 6,000 lb. of feed-water per hour. The full pressure of the exhaust steam is maintained in the heater, so that feedwater temperatures above 212 deg. F. are obtained when there is sufficient exhaust steam pressure available. It is designed for convenient attachment to the side of the locomotive boiler in a manner similar to that used for the attachment of air compressors.

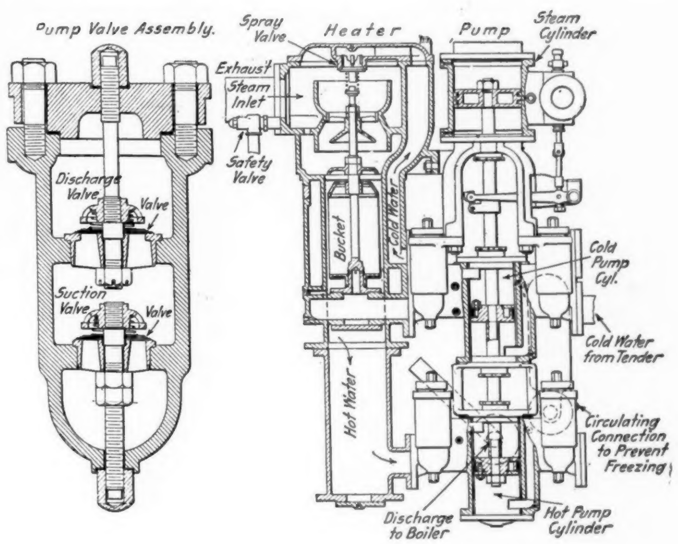


Pump and Heater Applied to Mikado Locomotive

The pump is of the vertical type with the steam cylinder at the top. It has two water cylinders, the upper or cold water cylinder taking cold water from the tender and delivering it to the heater, and the lower or hot water cylinder taking the heated water from the heater and delivering it to the boiler. The cold pump cylinder has a 6½-in. bore and the hot pump cylinder a 6 11/16-in. bore. Each of the pistons has four packing rings composed of ⅜-in. square (rock hard) piston packing. The drawing shows the pump valve assembly for both pump cylinders. The pump valves consist of three sheets of thin bronze, assembled with the smaller sheet on top and the largest on the valve seat. The valve seats, bolts, guards and springs are assembled before being placed in the pump. The suction valve seats are assembled with the long valve bolt projecting through the bottom of the pump chamber when the valves are in position. These valve seats make their joint on the pump chamber casting on the flat and not on the taper. The suction valves are held to their seat by the cap nuts on the lower end of the valve bolt, which are drawn up tight against two thin copper gaskets. The discharge valve seats are larger than the suction valve seats and also make their joint on the flat.

The heater is a cast iron box attached to the side of the pump by suitable pipe connections. The cold water, taken from the tender by the upper water cylinder, is delivered through a port in the side of the heater at the top, where it is sprayed into the upper part of the heater. Exhaust steam from the exhaust ports of the locomotive is led into this part of the heater through a six-inch opening in one side near the top. The cold water sprayed into this space condenses as much of this exhaust steam as is required to heat the water, and mixed with the condensate, drops to the bottom of the heater, where it is taken by the lower cylinder of the pump and delivered to the boiler. A ½-in. air vent is provided to prevent the accumulation in the heater of the air carried into it by the cold water and by the exhaust steam. A pipe from this air vent is led to a point where the air can conveniently be discharged between the rails.

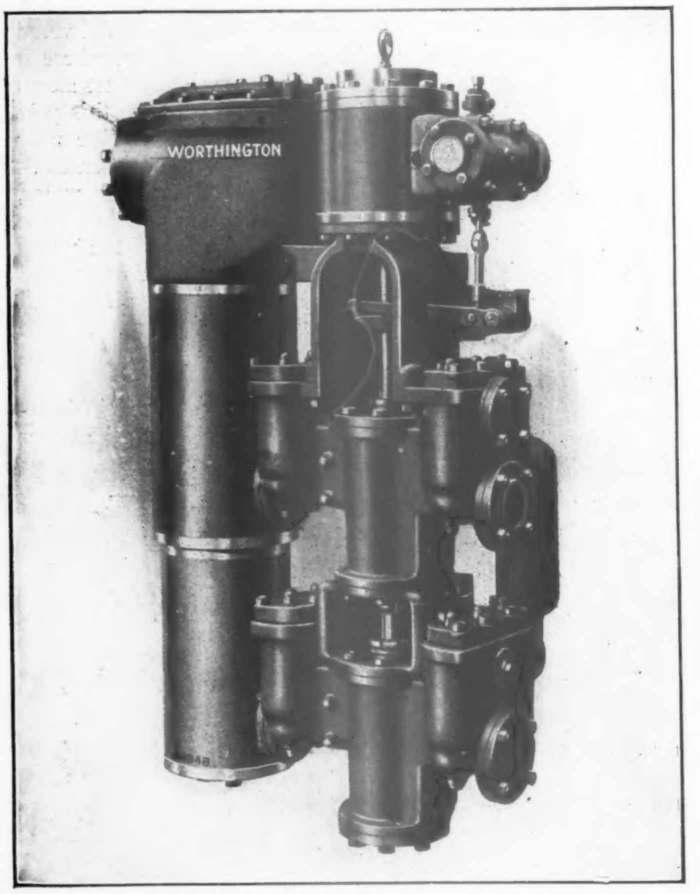
The varying amount of exhaust steam condensed in heating the water necessitates some means of regulating the water level in the heater, and this is accomplished by proportioning the pistons of the two pump cylinders so that there will be a tendency for a slight excess of water to accumulate in the heater. This excess of water will return to the upper pump cylinder where it mixes with the cold water from the tender passing through that cylinder, and is again delivered to the heater. The water level in the heater is regulated by a bucket which is free to move vertically on the central stem, and having holes in its top through which it is flooded when there is too much water in the heater, causing it to sink. In sinking it uncovers holes in the central stem on which it slides, permit-



Section of the Heater and Pump Valve Assembly

ting this excess of water to pass through a port to one of the suction valves of the cold water pump cylinder, from which it is returned to the heater with the water that is being taken from the tender. When the water level in the heater falls the bucket is partly emptied and rises, thus covering these holes and causing the cold pump cylinder to take all its water from the tender. The height of water in the boiler is regulated by the feed pump throttle, which consists of a 1¼-in. globe valve located in the cab. The valve connections between the heater and the locomotive are shown in the illustrations.

Exhaust steam is taken from the locomotive cylinders through holes cut in the back of the cylinder saddle casting and led through an angle stop check valve, thence through an oil separator having a continuous drip for the oil and water, and from this through the curved pipe to the top of the heater. The pump is driven by steam supplied through a pipe, which has a throttle valve conveniently located in the



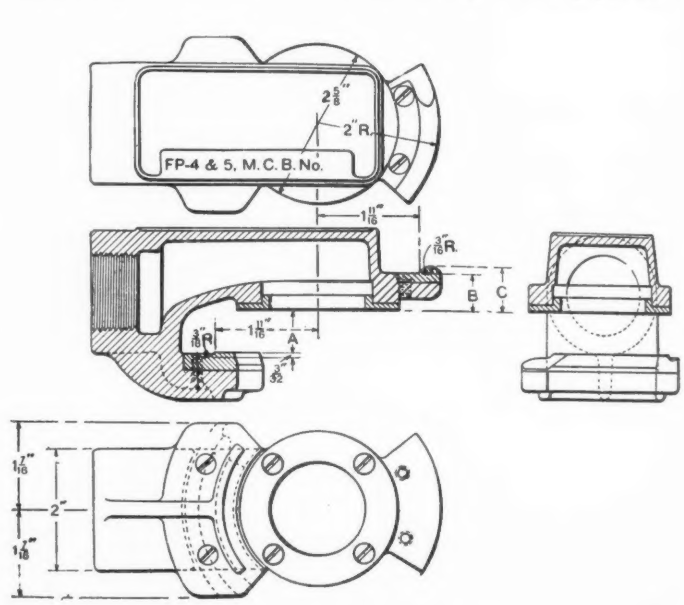
The Feed Pump and Heater

cab so that the pump can be operated at such speeds as conditions may require. The exhaust steam from the pump is led into the stop check valve, passes through the oil separator and thence to the heater with the exhaust steam from the locomotive. The pipe which conducts the cold water from the tender is shown passing behind the air compressor and entering the side of the upper or cold water pump cylinder. The heated feedwater leaves the lower or hot water pump cylinder by an opening in the rear and passes through a feed line to the boiler check valve.

So far as practicable the feed pump should be run continuously while the locomotive is in operation with the throttle open, but as the heater cannot recover any heat when there is no exhaust steam coming to it from the locomotive cylinders the injectors should be used when the locomotive throttle is not open.

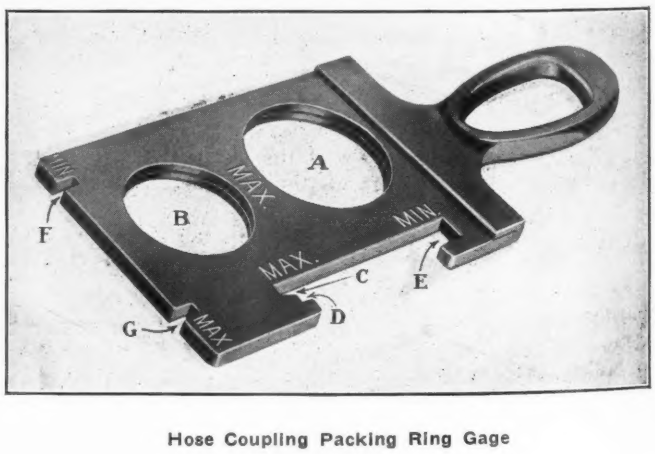
M. C. B. STANDARD HOSE COUPLING AND PACKING RING GAGES

The illustrations below show two gages adopted by the Mechanical Section of the American Railroad Association as recommended practice and now manufactured by the Westinghouse Air Brake Company, Wilmerding, Pa. The purpose of the hose coupling gage is to establish the amount of variation permissible in the guard arms of air brake hose couplings, which have become distorted or bent out of their normal position; and to determine whether the couplings are satisfactory for further use and interchange. The gages are



Gage for Testing Hose Couplings

intended for testing used couplings. Two gages are required for a set and, in practice, a coupling should enter gage No. 1 but should not enter gage No. 2. Couplings should be condemned when the guard arm is bent inward or outward from normal position; when bent inward the coupling will not enter gage No. 1 and when bent outward it will enter gage No. 2. The coupling may be used again by restoring the



Hose Coupling Packing Ring Gage

guard arm to its normal position. The Westinghouse Air Brake Company furnishes gages of the form shown for the standard FP-4 and FP-5 couplings.

Variations in the dimensions of hose coupling packing rings are a prolific source of air brake leakage. In order to overcome this condition the Master Car Builders' Association has adopted as recommended practice a limit gage shown on sheet Q1 of the 1917 Proceedings. This gage provides a

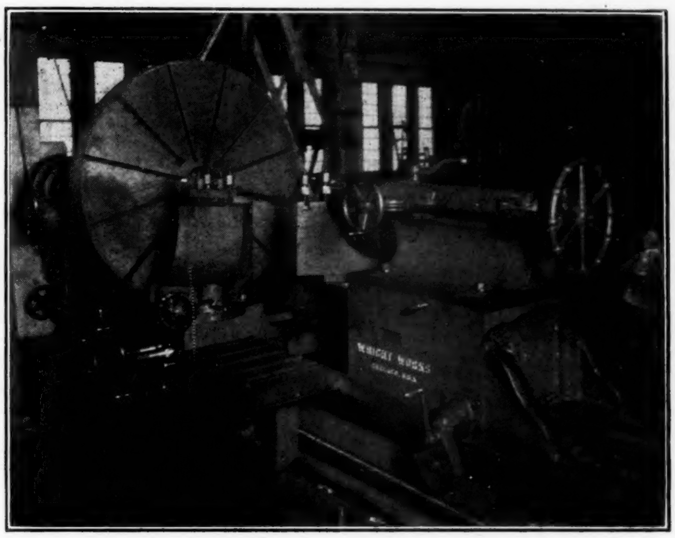
means for properly checking the maximum and minimum variations permissible in the dimensions of hose coupling packing rings, and further establishes a recognized standard for this item over the physical test specification. Opening *A* is for gaging the maximum and minimum external diameter of the packing ring flange. Opening *B* is for gaging the maximum and minimum external diameter of the projecting wall or face portion of the ring. Slots *C*, *D* and *E* are for gaging the height of the ring and the contour of the flange. Slots *F* and *G* are for gaging the maximum and minimum thickness of the projecting wall or face portion of the ring. Rings must enter all sections of the gage marked, *Max*, and must not enter any section of the gage marked *Min*.

A 96-IN. ENGINE LATHE

One of the largest lathes in the world, a 96-in. swing, triple geared Fifield engine lathe, has been produced by the Wright Works, Chicago. The machine is cone driven with the cone mounted on a back-shaft, this being necessary to obtain sufficient power to take the heavy cuts which would be required of a machine of this size. An eight-inch belt from a countershaft running at 200 r.p.m. transmits 40 hp. to the spindle of the lathe. The spindle is made of cast iron, on the theory that cast iron is less elastic than steel, and therefore will not spring when making heavy cuts, and for this reason reduces chattering. To compensate for the strength of a steel spindle the cast iron spindle is of generous proportions, the front bearing being 16 in. in diameter by 24 in. long, and the rear bearing 14 in. in diameter by 20 in. long.

The lathe is triple back geared and all changes in speed are obtained by moving the handwheel which is conveniently placed in front of the cone pulley within easy reach of the operator. The handwheel is geared to a lever shaft which materially reduces the effort required to shift the back gears into their desired positions. Only one change is made through sliding gears, the others being made by means of massive tooth clutches. The gearing and cone pulley is designed so that all speeds are in geometrical progression, the slowest speed being 0.75 r.p.m. and the fastest speed 76 r.p.m. Twelve speeds are obtainable through the four-step cone pulley and triple gearing with a ratio of 1.52 between each speed.

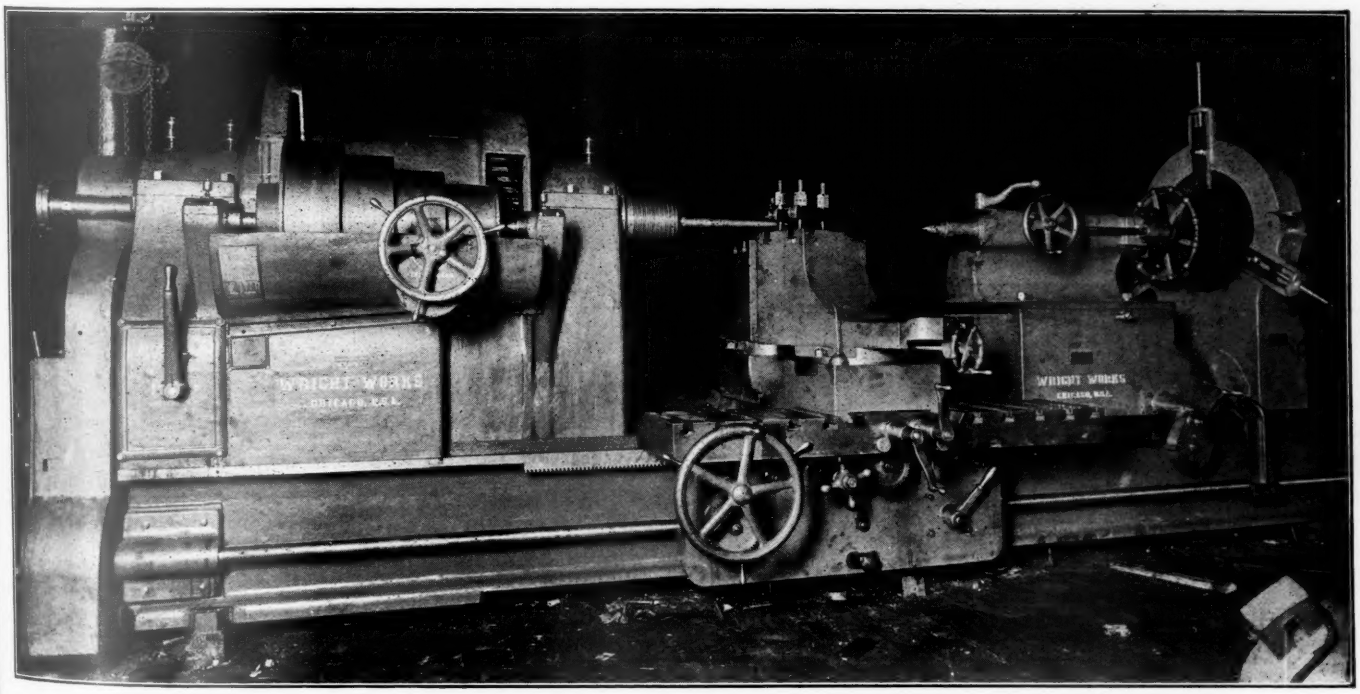
All of the gearing in the headstock, as well as throughout the machine, is made of steel and the pitch and width of face of the gears increase in proportion to the load which



Front View Showing the Massive Face Plate

the teeth are required to withstand in turning the faceplate at the slow speeds required for work of large diameter. The triple gear which engages the faceplate internal gear has a diametral pitch of one and a face width of six inches.

Every shaft in the headstock runs in phosphor bronze bearings and is well lubricated by means of sight feed oilers which are in view of the operator at all times.

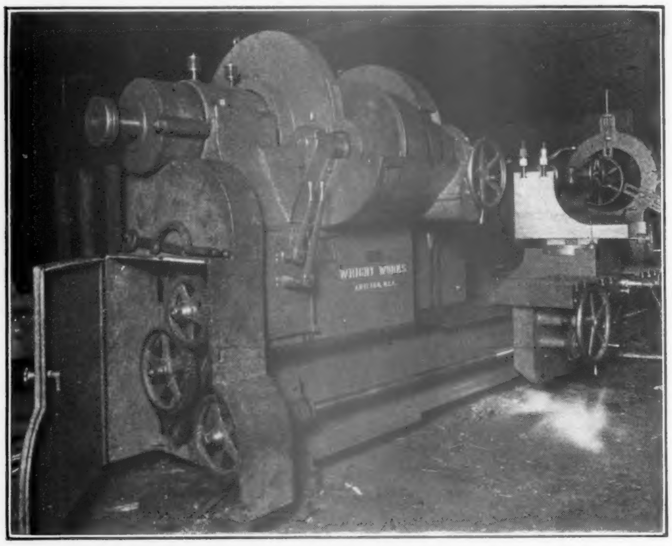


The Lathe with the Face Plate Removed

The feeds are also in geometrical progression and are obtained from a quick change gear box which is integral with the headstock. They are manipulated by the two levers shown in the illustrations, which move in either direction, giving four feeds of 0.025, 0.050, 0.100 and 0.200 in. for

each revolution of the face plate. More feeds may be had by changing the regular feed gears with the thread cutting gears. Twenty-four different threads may be cut by means of changing gears. All of the gears are guarded by covers or guards which are made conveniently removable where necessary while the gear change guard is provided with a door.

The carriage bears upon the ways for a length of 90 in.



End Showing the Change Gear

and is equipped with two compound cross slides which may be fitted with power angular feed if desired. The apron is fitted with steel gears and bronzed bushings throughout.

Buckling of the lead screw is prevented by means of supports which are adjustable and placed about 10 ft. apart.

The tailstock like the headstock is of box construction and is easily moved by hand by means of a geared device which engages the teeth in the rack on the bed. The tailstock spindle is moved by a bandwheel which is placed convenient to the carriage. A massive steady rest is provided with each machine.

The bed is ribbed throughout with box sections and is fitted with a rack down a center rib which engages a pawl on the tailstock, thus removing the thrust of a cut from the clamps of the tailstock direct to the bed of the lathe. The total weight of the machine is 150,000 lb.

A LOCOMOTIVE PULVERIZED FUEL EQUIPMENT

A pulverized fuel equipment for locomotives has been developed by the Fuller Engineering Company, Allentown, Pa., and has been applied to a Lehigh Valley locomotive. This equipment consists of a fuel tank on the tender, the fuel feeding apparatus, a special arrangement of combustion chamber, slag or ash pans and smoke box. The device is mounted on the tender deck and is operated by a reciprocating steam engine and a steam turbine driven fan.

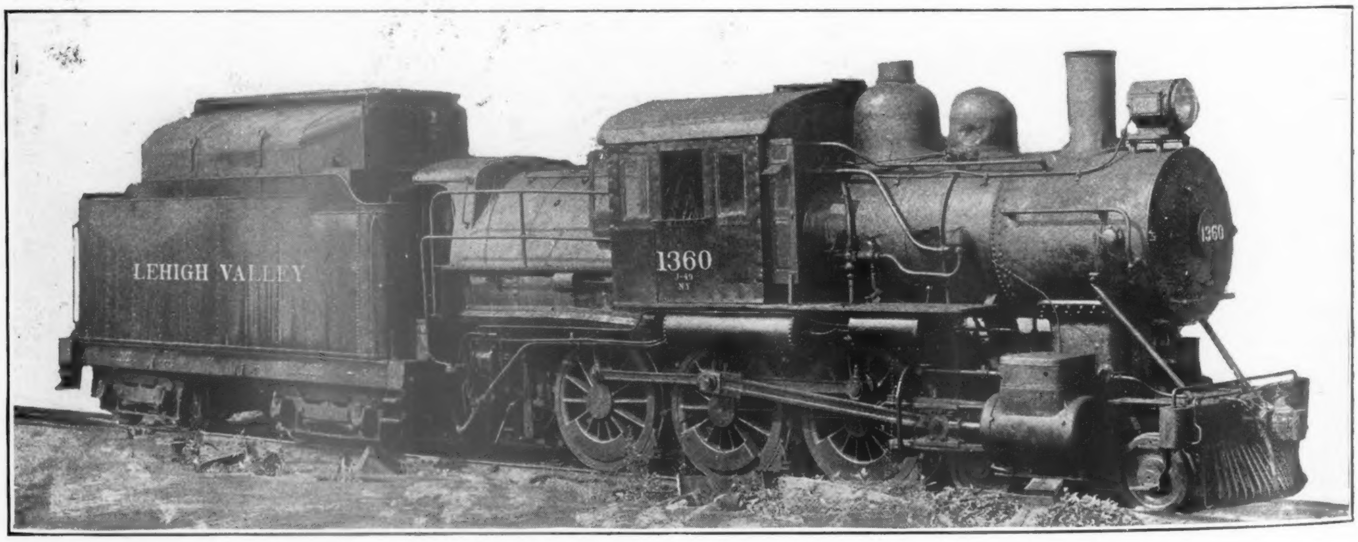
The standard brick arch supported on four 3½-in. arch tubes is applied in this locomotive as in hand fired practice, except that the arch is run within two feet of the back sheet and within about 12 in. of the crown sheet in the center, while the side bricks are not carried up so far.

The exhaust nozzles in this locomotive, of which there were two, were removed thus giving a free exhaust and eliminating all back pressure in the cylinders due to this cause. A sleeve has been secured to the end of the open exhaust stand and extended several inches up into the petticoat pipe. The petticoat pipe itself has been lowered 18 in. so that its lower end is now practically on a line with the center line of the boiler proper. This was done to reduce the draft in the front end, and thereby in the firebox, in order that the air and coal may enter the firebox at a velocity low enough to permit the coal to be completely consumed before being drawn over the arch, thus preventing the accumulation of slag on the flue sheet.

The pulverized coal tank is divided so that pulverized anthracite sludge may be carried in one side and bituminous coal in the other side. Very poor grades of coal can be burned in combination with soft coal by so manipulating the feed screws as to supply the proper proportions of soft coal and anthracite sludge necessary to maintain a proper temperature.

The apparatus for conveying coal from the tender to the locomotive consists of four 4-in. feed screws working in pairs and driven by a variable speed inclosed marine type two-cylinder double acting reciprocating engine. The fan for blowing the coal into the locomotive firebox is driven by a steam turbine. The turbine fan supplies approximately 15 to 20 per cent of the air required for combustion, the rest being drawn in by the action of the exhaust through the openings in the firebox and in the burner proper.

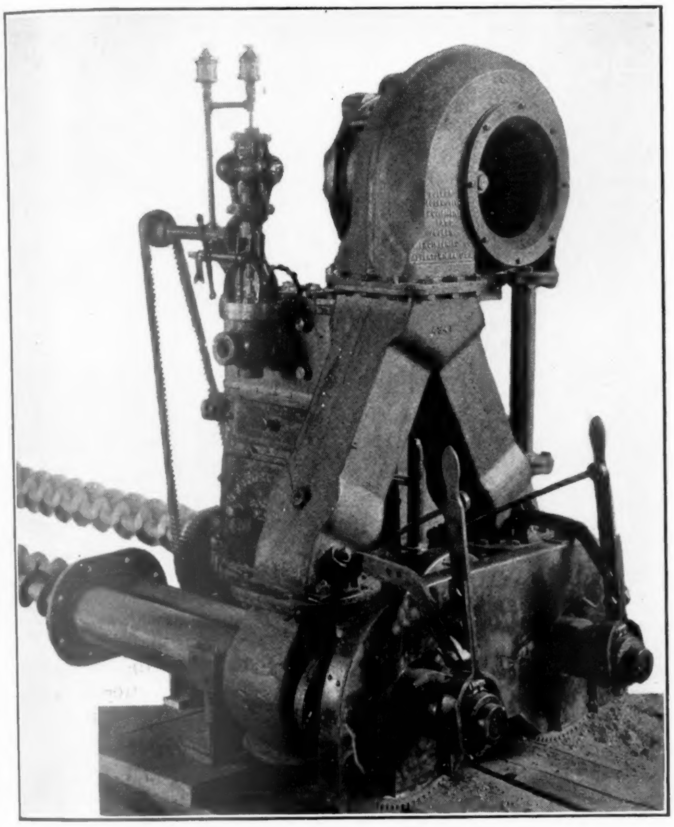
The four feeders operating in pairs prevent the fuel from arching over and feeding unevenly due to the tendency of



Lehigh Valley Locomotive Equipped with Pulverized Fuel Burning Apparatus

the coal to become tightly packed in the tender by the constant vibration while the engine is running.

The reciprocating engine, which drives the feeders by means of a steel pinion and gears, is controlled by a wide range variable speed governor connected to the crank shaft by a Morse chain drive. A flexible shaft, controlling this governor, enables the fireman to obtain a variation of 346 per cent in the speed of the reciprocating engine, and thereby of the coal which is fed to the locomotive, without leaving his seat in the cab.



The Apparatus as Installed on the Tender

As it is carried forward from the tank the coal is pushed over two small shelves in the enlarged end of the feeding casing, where it is spilled off in two cascades, which are in turn caught between three currents of air from the turbine fan mounted directly above. This arrangement causes the coal to thoroughly mix with the air before it is blown to the burner, where it is further diffused and more air added to it.

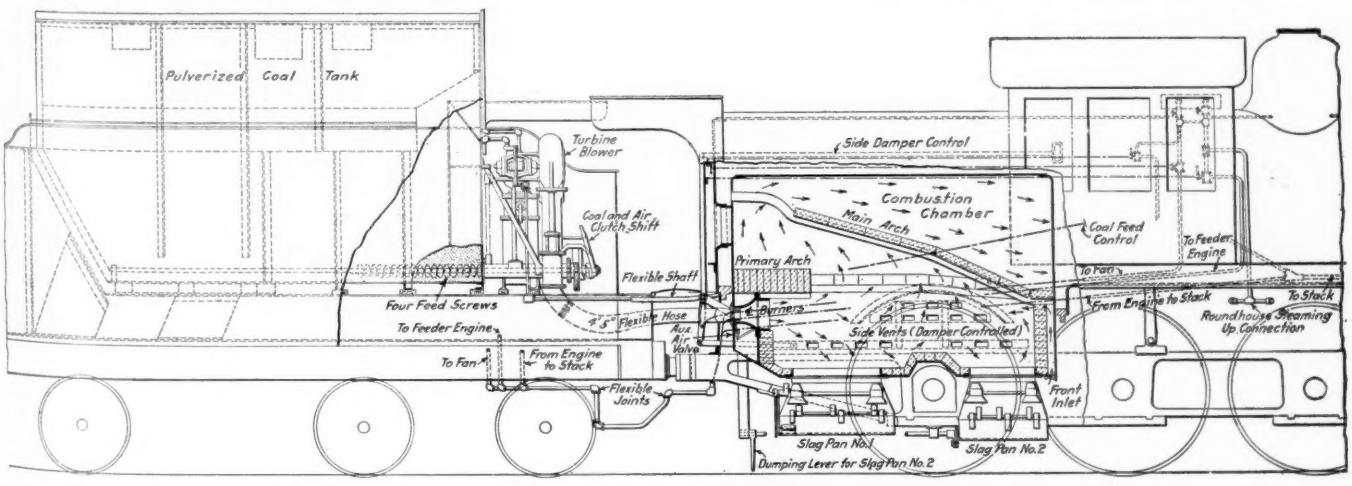
The turbine fan is driven at constant speed while in operation, the determining factor being that the pressure through the hose and in the burner shall distribute the flame evenly beneath the arch without causing it to impinge on the flash wall and thereby cause undue deterioration of the fire brick.

With the governor control and the two clutches a variation in coal feed of about 800 per cent between the minimum and maximum is obtainable with this apparatus, and the minimum can be reduced still further by throttling the steam in addition to the action of governor control.

Should either pair of the feeders become inoperative through some foreign matter being caught in them, the governor can be thrown out of operation and a single pair of screws can be driven at double the speed and thus supply sufficient fuel to operate the locomotive without failure. This wide range of speed is permissible as the ordinary maximum speed at which the reciprocating engine is run is less than half the speed of which it is capable, and this variation is also obtainable with the turbine fan without exceeding its rated capacity.

The maximum direct draft air pressure carried on the Fuller equipment is approximately three inches to four inches in the manifold beneath the fan or about $1\frac{3}{4}$ oz. to 2 oz., and this pressure is immediately reduced in the burner. A feature of the burner is that the flame spreads out and evenly fills the firebox beneath the arch no matter whether one pair or two pairs of feeders are in operation. The two pairs of feeders are thrown in or out as desired by the clutch shifters shown in the illustration and at the same time that either one of these is thrown out the air supply is also cut off from this side, thus preventing excess air from entering the burner.

A notable feature is that practically all of the air which enters the firebox, either through the burner or otherwise, is under the control of the fireman at all times, thus eliminating an excess of air and enabling the locomotive to be worked at maximum capacity without drawing in any more air than is necessary for complete combustion. At the same time this permits the velocity of the air entering the firebox through the different openings to be kept at a minimum. This is a desirable feature as it is chiefly the high velocity, accompanied by the abrasive action of the pulverized coal flame, and the high temperatures attendant thereto, which causes a rapid deterioration of the brick arch and the refractories in the firebox, while if these are properly controlled the life of the fire brick will be greatly prolonged.



Sectional View Showing the Application of the Pulverized Fuel Equipment

To aid in preventing and controlling excessive and destructive temperatures a pyrometer is supplied with all pul-

verized fuel equipment furnished by the Fuller Engineering Company. The thermo-couple of this unit projects into the firebox beneath the brick arch about midway between the front and back sheets, and an indicating unit registering directly in deg. F., in plain view of the fireman, so that by manipulating the dampers and coal feeding mechanism the temperature can be kept at the desired point.

As this is a double cab engine with a Wootten type firebox dual control is provided so that the fireman can control the apparatus either from the tender deck or from his seat in the cab. A pyrometer indicating unit, a revolution counter showing the rate of coal feed and steam gages, indicating the pressure on the turbine fan and the boiler pressure, are located in the cab.

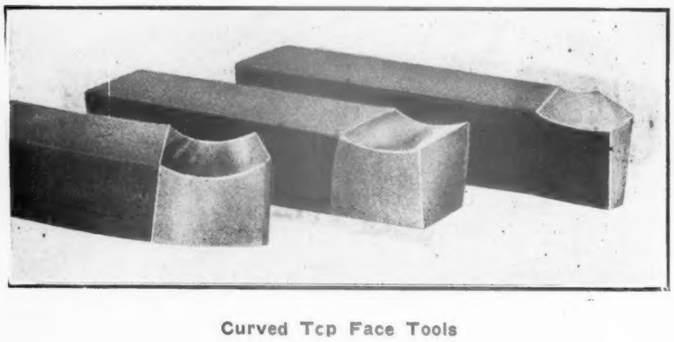
This apparatus as installed on the Lehigh Valley locomotive is designed to feed a maximum of approximately 4,600 lb. to 4,800 lb. of coal per hour, but this amount can be varied within considerable limits by simply changing the sprocket ratio between the governor and the feeder engine, or can still further be varied by changing the ratio between the pinion and gears driving the screws. This is a highly desirable feature as in this manner the same standard equipment can be used to feed a quantity of coal as low as 1,000 lb. or as high as 10,000 lb. an hour if desired, the only change necessary on the locomotive end being that different size burners and hose be employed for conducting the coal and air from the feeder to the burner.

The entire apparatus is assembled in one unit and can be secured to the pulverized coal tank with 18 bolts. It can be removed at any time without in any way disturbing the alinement of the gears, pinions, feed screws or any other part of the apparatus. As will be seen in the illustrations the whole apparatus is above the deck of the tender, where it is in plain view and easily accessible should any repairs or adjustments be necessary, and this feature also enables it to be applied to existing locomotives without cutting into the front water legs of the tender or without cutting below the tender deck to install it.

The apparatus as installed on the Lehigh Valley locomotive is said to have made a very creditable performance in a trip from the shops of the Fuller-Lehigh Company at Fullerton, Pa., to Atlantic City, during the recent convention of the mechanical section of the American Railroad Association, and also on its return trip to Fullerton.

THE LUMSDEN OSCILLATING TOOL GRINDER

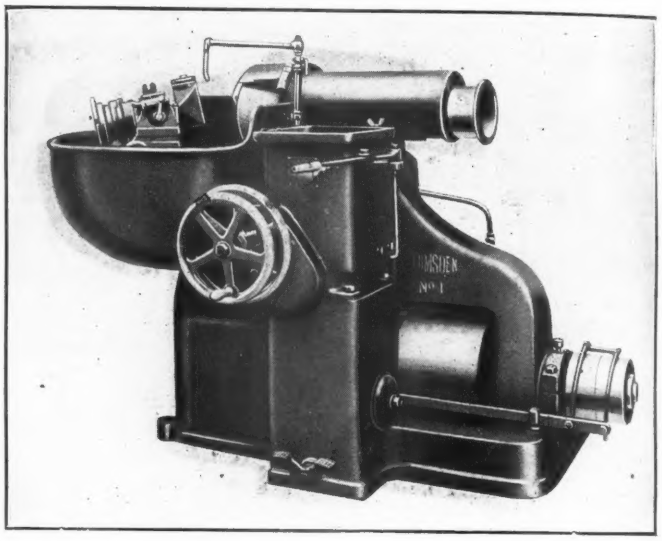
A tool grinding machine designed to eliminate a large amount of tool forging and to increase production is being placed on the American market by Alfred Herbert, Ltd., 54



Curved Tcp Face Tools

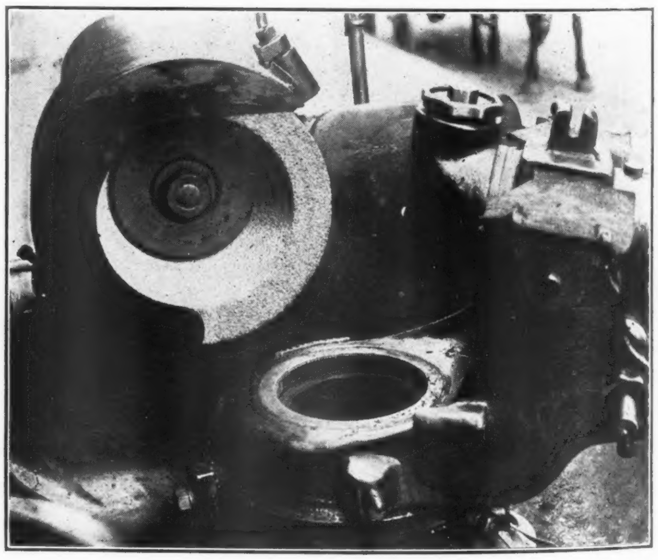
Dey street, New York. This is a British concern who developed this grinding machine during the recent war and are now introducing it in American shops. This machine is entirely self contained and may be driven by belt direct from the line shaft or motor.

The grinding wheel is mounted on an inverted pendulum frame resting in large trunnion bearings in the base of the machine and oscillated by power. A variable eccentric motion controlled by a single lever or handwheel regulates the amount of oscillation. This eccentric arrangement is coupled to the swinging frame by a connecting rod adjustably connected to the frame by a swiveling joint. This adjustable



Front View Lumsden Grinder No. 1

connecting rod is controlled by a large handwheel on the front of the gear box and provides means of bringing the grinding wheel into correct relation to the tool. The grinding wheel is also adjustable in the operating frame the adjustment being controlled by another handwheel on the gear box. This provides for the feed of the grinding wheel to and from the work. By means of these two handwheels,



Tool Holder and Grinding Wheel

easily reached by the operator, the grinding wheel may be moved sidewise and towards or away from the work without stopping the oscillating movement.

The lever controlling the oscillation is also located close to the operator's hand and the pedal for starting and stopping the machine is conveniently placed. This permits the operator to control the machine while standing in the best position to view the work being done.

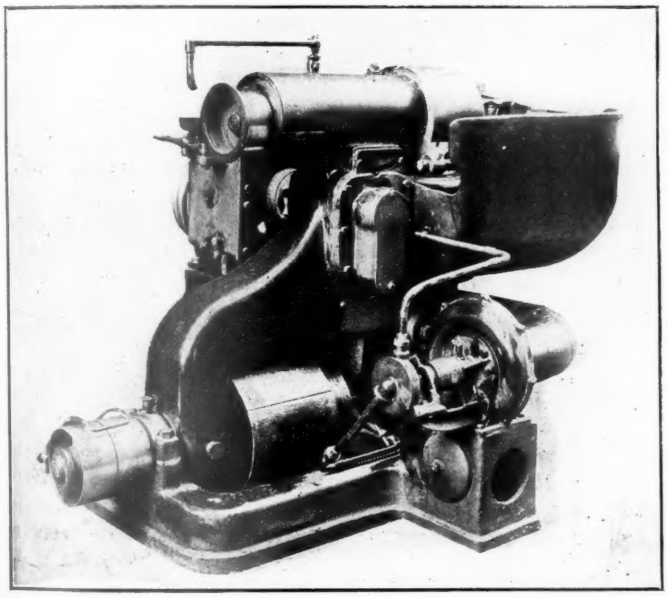
The tool holder is universally adjustable for all tools other

than those cranked to a right angle. A fixture for holding the latter and also for holding tools while being ground on the base is the only loose part used. The tool to be shaped is gripped in a simple chuck, which can be rotated through a complete circle on its own axis. The barrel which contains the chuck is carried in two trunnion bearings, so that the tool can be swung through an arc of about 10 degrees up or down. The trunnions have endwise adjustment in their bearings for use when grinding radius tools in which the center of the radius does not coincide with the center of the spindle. The whole tool holder can rotate on a vertical axis, enabling any side or the end of the tool to be presented to the wheel at any pre-determined angle. The tool holder is adjustable sideways on both sides of the center to allow the round nose of offset tools to be brought over the center of the vertical swinging movement.

The swivelling movement of the turntable on its vertical axis is extremely useful for grinding radius and round-nosed tools. To do this the tool is set so that the center of the desired radius is exactly over the axis of the turntable; then with the wheel stationary or oscillating but slightly the turntable is rotated back and forth until the desired curve merges into the sides and end of the tool.

Any shape or form of tool can be ground quickly without the use of a former, template or fixture other than the one specified, with the exception of tools which have a concave top face. Such tools may be ground by means of the curved face attachment, which is supplied for use on all Lumsden oscillating tool grinders. It consists of a swivelling tool holder fitted to a lever-operated slide and is arranged to fit in the tool holder of the machine. In using this device, the profile of a number of tools—the shape seen from the top—is first ground without the use of the attachment. They are then finished with curved top faces by means of the curved face attachment furnished with each machine in very little more time than would be required if they were ground with flat top faces. The degree of curvature given to the tool can be varied by commencing the grinding nearer to or farther from the cutting edge.

Duplicate tools can be shaped very rapidly by making use of the adjustable stops provided for each movement of the tool holder. Each movement also has its own secure clamping arrangements, holding the tool rigid while being ground.



Rear View Showing Dust Exhauster Fan and Pump

The grinding of new tools is done without the use of water, but when resharpening hardened tools water is necessary and the grinders are fitted with a pump and a tank for supplying water when required.

A powerful fan connected to a duct in the base of the tool holder draws all dust and chips away from the work and the operator and provision must be made when installing these machines to carry this away from the delivery pot of the fan.

With this machine only a small amount of rough forging is required for any tool within the range of the grinder and many tools may be ground from pieces of straight bar without any forging work except to bend the end of the tool when the desired shape requires it to be done.

THE EDLUND DETACHABLE BROOM HEAD

A broom having a detachable head and known as the "Edlund" is being manufactured by the Cleveland-Osborne Manufacturing Company, Cleveland, Ohio. The broom consists of a metal holder with a clamping device and a detachable filler or broom.

The holder and clamping device is of pressed sheet steel secured to a wooden handle and is arranged with a rectangular socket, into which the filler or broom is inserted and secured by the clamp. The device is constructed so that the filler can be inserted in the holder by slipping a ring off the broom clamp and so placing the filler that the bead on the filler fits into a groove in the holder. The ring is then pushed over the clamp, thus securing the broom firmly in place.

These brooms are made of bass, bassine or bahia fibre and are furnished in grades suitable for the service in which they are to be used. They have given most satisfactory and economical service in factories, railway shops and storehouses, and tests have shown that the Edlund broom will outwear from four to six of the ordinary corn brooms. These brooms can be worn to a very short length because of the manner in which the fibres are bound together and the percentage of waste is very low. The holder is so constructed that with ordinary use it will last indefinitely and it is only necessary to purchase additional fillers, which, because of their simple construction and durable material, reduce the broom cost to a minimum.

The Edlund Broom

Railway Mechanical Engineer

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with which the AMERICAN ENGINEER *was incorporated)*

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WE GUARANTEE, that of this issue 10,600 copies were printed; that of these 10,600 copies 9,582 were mailed to regular paid subscribers, 20 were provided for counter and news company sales, 210 were mailed to advertisers, 28 were mailed to employees and correspondents, and 610 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 73,210, an average of 9,151 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

During the month of June 169 locomotives were built, 12 in company shops, 45 by the builders on orders prior to federal control and 112 U. S. R. A. standard locomotives.

The shops of the New York, New Haven & Hartford at Valley Falls, R. I., were destroyed by fire on the night of July 26; estimated loss $130,000. The fire was started by lightning.

It is reported from Petrograd that the number of discarded Russian locomotives which can no longer be used amounts to nearly 60 per cent of the total stock. About one-fourth of the railway carriages are in the same state.

The National Screw Thread Commission sailed for Brest from Hoboken, N. J., on July 13, to meet French engineers in Paris and then proceed to London, for the purpose of making a tentative agreement on pipe thread standards with the British Engineering Standards Association.

The Pennsylvania System federation of employees, composed of six crafts employed in the shops of the railroad, held their first annual convention at Columbus, Ohio, on July 14. The federation represents more than 40,000 men employed in various shops of the Pennsylvania System.

It is reported that the Texas & Pacific Railroad will have more than 200 of its engines equipped for using oil as fuel in a short time, for service on the entire line between New Orleans and El Paso. The Texas & Pacific has had a few oil burning locomotives in use for several years.

Locomotives which were pooled to meet the exigencies of war conditions have now been practically all returned to the roads on which they were originally operated. All are said to have been repaired and placed in good condition before being returned. The total number under lease to various roads was about 800.

The Pennsylvania Lines West of Pittsburgh will build a group of repair shops at Stark, Ohio, to consist of a locomotive erecting shop, heavy and light machine shops, tank shop, flue shop, wheel and pipe shop, blacksmith shop, firing up shed, storehouse, office building, rest house and shed for the storage of miscellaneous material.

According to an Associated Press despatch the work of recovering stolen Belgian machinery from Germany is proceeding with full swing. Approximately 3,000 tons of machinery are being shipped back weekly to the original owners by German industrial firms, who had set them up in their own factories. The total tonnage returned to July 1 was 18,000.

It has been demonstrated that it is possible to make pig iron and iron castings direct from steel scrap in an electric furnace, and it is claimed that such iron, cast in the form of castings, is far superior to the same castings made from ordinary pig iron melted and cast. Tests recently made at Columbia University show its tensile strength to be 40,730 to 45,030 lb. per sq. in., considerably higher than of ordinary cast iron.

The shops of the Pullman Company at Ludlow, Ky., recently destroyed by fire, will probably not be rebuilt, according to a letter from Director General Hines to the Chamber of Commerce. The letter states that the shops were obsolete and that their usefulness was limited. Mr. Hines also asserts that many of the men formerly employed in the Ludlow shops have secured other positions and therefore were not greatly discommoded by the nonexistence of the plant.

Three hundred shop employees of the Southern Railways at Alexandria, Va., went out on strike on June 17 by way of protest against what they term the delay in passing on the proposed uniform rules and working conditions and also the general demand of the shop employees for an advance in wages which have both been before the Board of Wages and Working Conditions for some time. The strike was unauthorized and the men returned to work later in the day.

Enginemen on the Southern Railroad went on strike because they were required to run large new engines of the Santa Fe type through the numerous tunnels between Danville, Ky., and Oakdale, Tenn. With these engines the clearance at the sides and top is so small that the flow of fresh air is seriously checked; so much so that in hot weather the enginemen have reported temperatures in cabs of 140 deg. F. Fans to ventilate the cabs, by air drawn from below the pilot, are being fitted to the engines.

Losses of gasoline during transit are estimated by one prominent producer and shipper of gasoline to amount to eight per cent, considering only that shipped in tank cars. During 1918, about 3,500,000,000 gallons of gasoline were produced in the United States and much of it was shipped

more than once. A loss of one per cent, at 20 cents a gallon, means a loss to the shippers and to the nation of $7,000,000. The railroad loss and damage figures recently published, are large, but the shippers' probable wastage through leakage and evaporation during transit is larger.

Railroad Administration reports show that 101,785 women were employed in railroad service in September, 1918, while in April, 1919, there was a reduction of 14.3 per cent, or a total still employed of 85,393. This was partly due to the general reduction in the labor forces and also to the return of the soldiers from army service. The largest percentage of decrease was from among the clerical force. In the mechanical section the largest number of reductions among the women employees took place in the roundhouses and shops. Their work in these departments was in many cases found to be unsatisfactory, the work being generally considered too heavy.

Representatives of the coal operators, as part of their propaganda to induce the early buying of coal, are already complaining of an impending car shortage and are urging the Railroad Administration to take more active steps to put cars in repair. The directors of the National Coal Association in resolutions recently adopted, declare serious car shortages exist, and that there is an abnormally large number of cars out of service awaiting repairs. George H. Cushing, managing director of the American Wholesale Coal Association, testified at Washington on July 18 before a House committee that there are many idle coal cars in all parts of the country which should be repaired.

The *Monthly Labor Review,* published by the United States Department of Labor, contains an article on the employment of women in acetylene welding, in which it is stated that they have demonstrated that they are better suited to the lightest sorts of welding than men. In England short welding courses were instituted early in the war with decided success and welding courses in many of the technical schools are now open to women. English women have done all types of welding with marked success, but in the United States they have not been given as many or as difficult types of work. It is the consensus of opinion that they have been most successful in the lighter grades of work, such as are centered in the airplane manufacturing around Detroit and it is agreed that work from which very heavy lifting cannot be eliminated is unsuitable for them. The estimates of welding authorities place the number of women welders in this country at from 1,000 to 1,500 or more, but very few of these are sufficiently skilled to do general high class welding repair work.

Bureau of Standards Studying Paint Standards

The Bureau of Standards of the United States Department of Commerce is engaged in a study of paint and paint materials in connection with a committee of scientific representatives of the government departments, including the Railroad Administration, with a view of making acceptable standard specifications to be promulgated by the bureau for the information of the public which, when issued, it is stated, will make available to the railroads a fund of information regarding paint which they have not had heretofore. Percy H. Walker of the Bureau of Standards is chairman.

Railroad Men Wanted in Russia

A request has been received at the office of the chief of engineers, War Department, Washington, from the Russian Railway Service Corps for additional men to serve on Russian railroads. At the present time there is need for first class accountants, store and material men, stenographers, shop superintendents, trainmasters, traveling engineers, round-house foremen, car foremen and foundry superintendents. These men will not be in the United States Army, but will wear a uniform and be members of the Russian Railway Service Corps, a separate service formed for the specific purpose of handling railway matters in Russia. Accountants and store material men will receive from $2,000 to $2,500 a year, shop superintendents approximately $5,000 a year, trainmasters and traveling engineers $2,500, roundhouse foremen and car foremen $2,000, and foundry superintendents $3,000. Col. L. M. Wright, Director General of Military Railways, Office of Chief of Engineers, Washington, D. C., is handling inquiries concerning the service.

Machine Tool Builders Withdraw Opposition to Government Sales Abroad

As the result of an explanation by Secretary of War Newton D. Baker of sales and machine tools abroad by the United States army, Cincinnati machine tool builders are said to have withdrawn their objections to such sales. The State Department inquired of the War Department for information regarding the sale of machine tools in Belgium and France and Secretary Baker's reply is in part as follows:

"The policy of this department is to dispose of surplus material both at home and abroad as rapidly as possible and with as little disturbance of the trade as is practical under the circumstances.

"In the United States each bureau is, thus far, making its own sales through its district offices under the policy set forth by the director of sales. A representative of the director of sales has been negotiating the sales abroad.

"Sales to date in this country have totaled $3,200,411.10 for machinery, machine tools and engineering equipment which cost the government $3,898,833.85. We have therefore disposed of this material for 82 per cent of the cost to the government, which, I think you will agree, is a very creditable showing and does not indicate any disposition on the part of the War Department to disturb the home market.

"The sale which is being negotiated with the Belgians by our representatives abroad is for slightly used machines in good condition on the basis of August 1, 1914, prices, plus 55 per cent c. i. f. Antwerp.

"The average advance reported by 133 manufacturers of this line from 1914 to 1918 was approximately 93 per cent. Since the armistice the average drop on new machinery has been about 20 per cent.

"One of the largest houses reconditioning used machinery states that in normal times their sales of entirely made-over machinery average around 75 per cent of new. For this machinery, sold as it stands, you will readily see that we are not offering it at improperly low prices, as stated by your correspondent, but at very fair prices which ought not materially disturb the trade for new machinery."

MEETINGS AND CONVENTIONS

Traveling Engineers Association.—The annual meeting of the Traveling Engineers' Association, to be held at Hotel Sherman in Chicago in September, will begin on the 16th instead of the 9th; and will hold through Tuesday, Wednesday, Thursday and Friday, ending on the 19th.

International Railway General Foremen's Association.—General car foremen are invited to attend the convention of the International Railway General Foremen's Association, which will be held at the Hotel Sherman, Chicago, on September 2 to 5, inclusive. One of the topics under discussion will be draft gears.

Master Car and Locomotive Painters' Association.—The forty-eighth annual convention of the Master Car and Locomotive Painters' Association will be held at the Hotel LaSalle, Chicago, commencing September 9. The association has held no meetings during the past two years, and the program for this year's convention is practically the same as

that selected for 1917. The following papers will be presented: The Advantage of Using Pure Paints and More Time in the Painting of Steel Equipment, by Warner Bailey (B. & M.); What Quality and Size of Sand Pebble Are the Best for Blasting Paint or Corrosion From Steel or Iron, Preparatory to Painting, by J. W. Gibbons (A. T. & S. F.), S. E. Breese (N. Y. C.) and George M. Oates (Pressed Steel Car Company); The Record of Our Association, by Charles E. Copp (B. & M.); What Standardization of Painting Railway Equipment Is Necessary, Based Upon the Experience of This Association? by W. A. Buchanan (D. L. & W.), H. M. Butts (N. Y. C.) and W. O. Quest (P. & L. E.); Is the Demand for Linseed Oil as a Paint-Making Oil in Excess of the Supply; If So, What Other Oils Are Most Acceptable Substitutes for the Railway Paint Shop? by A. H. F. Phillips (N. Y. O. & W.), P. J. Hoffman (Hocking Valley) and F. B. Davenport (Penn. Lines).

Master Blacksmiths' Association.—The International Railroad Master Blacksmiths' Association has announced the following papers which are to be presented at the convention to be held at the Hotel Sherman, Chicago, August 19-21: Repairs to Locomotive Frames, P. Lavender (N. & W.), chairman; Drop Forging and Its Possibilities, J. D. Boyle (Anderson Drop Forge Company), chairman; Heat Treatment of Iron and Steel, Purposes and Results, G. Hutton (N. Y. C.), chairman; Why Railroads Should Adopt Specific Standard Safety Appliances to Comply with U. S. Standards, J. E. Dugan (U. P.), chairman; Making and Repairing Springs, John W. Russell (Pa.), chairman; Up-to-Date Smith Shop, G. Fraser (A. T. & S. F.), chairman; Scrap Reclaiming by use of the Oxy-acetylene and Electric Cutting and Welding Process and Other Methods, Walter Constance (St. L. & S. F.), chairman; The Treatment and Results of Carbon, High Speed and Other Alloy Tool and Tool Steels for Tools, J. H. DeArment (Pa.), chairman; A Modern Hammer and Hydraulic Forge Shop, R. F. Scott (P. & R.), chairman. The officers of the association are: President, W. C. Scofield (I. C.); chairman executive committee, W. J. Mayer (M. C.); first vice-president, J. Carruthers (D. M. & N.); second vice-president, G. P. White (M. K. & T.); secretary, A. L. Woodworth (B. & O.); assistant secretary, C. W. Shafer (C. of Ga.).

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD ASSOCIATION, SECTION III—MECHANICAL.—V. R. HAWTHORNE, 431 Scuth Dearborn St., Chicago.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago. Convention, August 27-29, Hotel Sherman, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St.. New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—H. J. Smith, D. L. & W., Scranton, Pa.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio. Convention Aug. 19-21, Hotel Sherman, Chicago.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention September 2-5, 1919. Hotel Sherman, Chicago.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass. Convention, September 9, Hotcl La Salle, Chicago.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention, September 16-19, Hotel Sherman, Chicago.

PERSONAL MENTION

It is our desire to make these columns cover as completely as possible all the changes that take place in the mechanical departments of the railways of this country, and we shall greatly appreciate any assistance that our readers may give us in helping to bring this about.

GENERAL

J. B. CAROTHERS, assistant to the federal manager of the Baltimore & Ohio, Western Lines, with headquarters at Cincinnati, Ohio, has had his jurisdiction extended over the departments of fuel and locomotive operation.

H. P. DOUGHERTY has been appointed assistant director of the Division of Labor, United States Railroad Administration.

C. I. EVANS, whose appointment as chief assistant mechanical superintendent of the Missouri, Kansas & Texas and associated railroads, with office at Denison, Texas, was announced in these columns last month, was born in Bedford, Iowa, and was educated in the high schools. Before entering the service of the Missouri, Kansas & Texas he had been for six years employed as a fireman and engineman on other roads. He has been with the Missouri, Kansas & Texas for 25 years, having started as a locomotive engineman, later being promoted to road foreman of engines. Subsequently he served as trainmaster, then as lubricating expert, and at the time of his recent appointment he was chief fuel supervisor. In his present position he has direct charge of shops and all matters connected with the maintenance of locomotives and cars and reports to the general manager.

D. R. MACBAIN, whose appointment as assistant general manager of the New York Central, Lines West, with headquarters at Cleveland, Ohio, was announced in these columns last month, was born on October 23, 1865, at Queenstown Heights, Ont., and was educated in the common schools. He entered railway service in October, 1876, as a machinist apprentice on the Canadian Southern, and was later locomotive fireman and then locomotive engineman on the same road. From 1890 to July, 1900, he was a traveling engineer on the Michigan Central, and then until June 23, 1906, was master mechanic, latterly at Jackson, Mich.

D. R. Mac Bain

On the latter date he was appointed assistant superintendent motive power at Detroit, Mich. From April 1, 1908, to May, 1910, he was assistant superintendent of motive power of the New York Central & Hudson River at Albany, N. Y. On May 15, 1910, he was appointed superintendent motive power of the Lake Shore & Michigan Southern, the Lake Erie & Western, the Lake Erie, Alliance & Wheeling, the Dunkirk, Allegheny Valley & Pittsburgh, the Cleveland Short Line, the Chicago, Indiana & Southern and the Indiana Harbor Belt. Later he was appointed superintendent of motive power

of the New York Central Lines West, with headquarters at Cleveland, Ohio, which position he held until he was recently appointed assistant general manager of the same lines.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. D. BARNES, road foreman of engines of the Central of Georgia, with headquarters at Macon, Ga., has been appointed trainmaster of the Macon division, with headquarters at Macon, succeeding H. R. Frierson.

L. E. FLETCHER, master mechanic of the Atchison, Topeka & Santa Fee at Raton, N. M., has been transferred to the Arkansas River and Colorado divisions, with headquarters at La Junta, Colo., succeeding I. H. Drake, assigned to other duties.

FRANK LAFOND has been appointed road foreman of engines of the Los Angeles division of the Southern Pacific (lines south of Ashland), with headquarters at Los Angeles, Cal., succeeding R. N. Richardson, assigned to other duties.

T. T. RYAN, general foreman of the Atchison, Topeka & Santa Fe at Las Vegas, N. M., has been appointed master mechanic of the New Mexico division, with headquarters at Raton, N. M., succeeding L. E. Fletcher.

CAR DEPARTMENT

M. C. DEVINE has resumed his duties as general car foreman of the Missouri, Kansas & Texas at Sedalia, Mo., having been engaged in government inspection work in Hammond, Ind.

SHOP AND ENGINEHOUSE

J. SKELTON has been appointed day roundhouse foreman of the Denison (Texas) locomotive shops of the Missouri, Kansas & Texas, succeeding J. T. Smith, who is now night foreman.

PURCHASING AND STOREKEEPING

T. S. EDGELL has been appointed division storekeeper of the Mobile & Ohio at Murphysboro, Ill., succeeding E. H. Landers, resigned to accept service with another company.

R. R. JACKSON has been appointed division storekeeper of the Pittsburgh division of the Baltimore & Ohio, Eastern Lines, with headquarters at Glenwood, Pa., succeeding T. C. Hopkins, assigned to other duties.

H. P. MCQUILKIN, assistant general storekeeper of the Baltimore & Ohio, Eastern Lines, has been appointed general storekeeper of the Baltimore & Ohio, the Cumberland Valley, the Western Maryland and the Cumberland & Pennsylvania, with headquarters at Baltimore, Md. Mr. McQuilkin was born on February 6, 1887, at Martinsburg, W. Va., and was educated in the public and high schools of his native town. He began railway work on April 1, 1905, as distributor in the stores department of the Baltimore & Ohio at Cumberland, Md., and the following year served as clerk in the motive power department. He was out of railway work from October, 1906, to September, 1910, and then became storekeeper on the Baltimore & Ohio, at Connellsville, Pa. He was later storekeeper at Washington, Ind., and from April, 1914, to December, 1916, was district storekeeper for the Baltimore & Ohio and the Cincinnati, Hamilton & Dayton at Cincinnati. He was then, to April, 1918, chief clerk to the general storekeeper on the Baltimore & Ohio at Baltimore, and subsequently served consecutively as chief clerk to the purchasing agent until June, 1918, and assistant general storekeeper, until his promotion to general storekeeper on the same road.

P. H. SHAY has been appointed storekeeper of the Lehigh Valley, with headquarters at Caxton, Pa.

GORDON THOMAS has been appointed storekeeper of the Lehigh Valley, with headquarters at Hazleton, Pa.

R. E. WALKER has been appointed storekeeper of the Lehigh Valley, with headquarters at Auburn, N. Y.

OBITUARY

JOSHUA A. LEACH, founder of the Brotherhood of Locomotive Firemen & Enginemen, died on June 27, at Denver, Colo., where he was attending the organization's triennial convention. Mr. Leach organized the Brotherhood of Locomotive Firemen & Enginemen at Port Jervis, N. Y., in 1873. He was 76 years old.

OSCAR OTTO, general superintendent of the South Philadelphia Machine Works of the Westinghouse Electric & Manufacturing Company, died on June 30, as a result of injuries received in an automobile accident near Westgrove, Pa. He was born in Manitowoc, Wis., on January 2, 1859, and after finishing his apprenticeship course as a machinist in the Manitowoc shops of the Chicago & North Western, served during several years at various places in Wisconsin. He then entered the service of the Northern Pacific, at Tacoma, Wash., going from there to the Oregon Short Line, at Salt Lake City, Utah. In 1898 he returned to the service of the Chicago & North Western as superintendent at the Chicago shops. Prior to accepting a position as general superintendent of the Westinghouse Machine Works, at East Pittsburgh, Pa., in June, 1909, he was connected with the Chicago & North Western as general superintendent of its Chicago shops. When the Westinghouse Company opened its new plant at Essington, Pa., Mr. Otto supervised the installation of the machinery, and later in February, 1918, he was transferred to the new works, where he remained until his death.

MATTHEW J. MCCARTHY, superintendent of maintenance of equipment of the Baltimore & Ohio, Lines West, with headquarters at Cincinnati, Ohio, died at his home in that city on July 12. He was born at Susquehanna, Pa., in 1868, and began railway work in 1889 as an apprentice on the Erie, and subsequently worked in a number of railroad shops in the west and southwest as machinist and foreman. He was for ten years in the service of the Chicago, Burlington & Quincy, at Burlington, Iowa, as machinist inspector and general foreman, then was with the Michigan Central, as division master mechanic at St. Thomas, Ont., for four years, and during the next two years served as division master mechanic on the Lake Shore & Michigan Southern. Mr. McCarthy then went to the Cleveland, Cincinnati, Chicago & St. Louis, as superintendent of shops at Beech Grove, Ind., and later was assistant superintendent of motive power at Indianapolis. on the same road. In January, 1913, he was appointed superintendent of motive power of the Baltimore & Ohio Southwestern and the Cincinnati, Hamilton & Dayton, at Cincinnati, Ohio, later his title was changed to superintendent of maintenance of equipment of the Baltimore & Ohio, Lines West.

M. J. McCarthy

SUPPLY TRADE NOTES

The Edison Storage Battery Company announces the removal of its district office in Pittsburgh, Pa., to room 431 Union Arcade building.

The Camden Forge Company, Camden, N. J., has opened a district sales office at 2 Rector street, New York, with Samuel W. Hilt as manager.

J. E. Slimp has been appointed general manager of the Unit Railway Car Company, Boston, Mass., manufacturers of interurban and short line railway cars.

Harold E. Wade has been appointed president of the Fairmont Gas Engine & Railway Motor Car Company, Fairmont, Minn., succeeding Frank E. Wade, deceased.

The Walter A. Zelnicker Supply Company, St. Louis, Mo., has added 2,000 sq. ft. to its present office space at 325 Locust street, St. Louis, an increase of 33 1/3 per cent.

The Chicago Pneumatic Tool Company, Chicago, has removed its Minneapolis (Minn.) office from the Metropolitan Bank building to Fifth avenue and Fifth street south.

H. A. Wolcott has been appointed district manager of the Ohio Locomotive Crane Company, Bucyrus, Ohio, for the Chicago territory, with office in the Lytton building, Chicago.

E. H. Roelofs, assistant engineer of motive power on the Philadelphia & Reading, with headquarters at Reading, Pa., has resigned to enter the service of the Baldwin Locomotive Works.

J. L. Dahl has been appointed manager of the New York office of the Gregg Company, Ltd., Hackensack, N. J. He succeeded C. R. Gier, who is no longer in the employ of the company.

D. C. Schultz, Sr., who has had a wide experience in the design and sale of Morgan & Northern cranes, has been appointed sales manager of the Pittsburgh Crane & Equipment Co., with headquarters at Sharpsburg, Pa.

Frank O. Leitzell, assistant to the general manager of the H. K. Porter Company, Pittsburgh, Pa., has been appointed an engineer-salesman in the sheet and tin mill specialties department of the Blaw-Knox Company, Pittsburgh, Pa.

John McConnell, who had charge of alloy steel production for the Interstate Iron & Steel Company, Chicago, as assistant to the vice-president with headquarters at Canton, Ohio, has been promoted to vice-president with headquarters at Chicago.

Major John L. Wood, formerly connected with the Buckeye Steel Castings Company, Chicago, and interested in several railway supply companies, including Edwin S. Woods & Co., Chicago, died on June 13 at Pasadena, Cal., after a protracted illness.

Robert S. Hammond, formerly sales agent of the American Steel Foundries, Chicago, has been appointed Pittsburgh (Pa.) representative of the Whiting Foundry Equipment Company, Harvey, Ill., with office in the Fulton building, succeeding F. J. Page.

The Ulster Iron Works, Dover, N. J., has completed a new puddling mill at Dover, with the main building 390 ft. by 77 ft. and an adjoining wing 90 ft. by 60 ft. Eleven double puddling furnaces are now being operated and 11 additional furnaces of the same type will be installed. The entire output of the mill is distributed by Joseph T. Ryerson & Son, Chicago.

The Liberty Car Wheel Company, Hammond, Ind., has been incorporated with $500,000 capital stock and the following officers have been elected: President, Patrick H. Joyce; vice-president, F. O. Bunnell; treasurer, John E. Fitzgerald; secretary, Charles Aaron.

Lieut.-Col. Elmer K. Hiles, Engineers, A. E. F., who went over as captain in the Fifteenth Engineers, has returned after nearly two years' service in France, and has joined the Pittsburgh Testing Laboratory as manager of laboratories, with headquarters at Pittsburgh.

Elliot Reid, assistant to general manager of the Westinghouse Lamp Company, 165 Broadway, New York, has been appointed sales manager, and will have charge of the commercial activities of the company in both large and miniature classes of lamps in domestic territory.

Arthur Osmore Norton, president of A. O. Norton, Inc., Boston, Mass., died while writing a letter, on June 8, in his home at Coaticook, Que. He was born on February 17, 1845, on a farm in Barnston township, about ten miles from Coaticook. The family moved to a farm in Coaticook when he was a small boy, and he began his business career as a clerk in the country store. When he was about 30 years old, he started a jewelry business in Coaticook, later doing a wholesale business, and subsequently was in the wholesale jewelry business in Boston under the firm name of Norton Brothers & Butters. In 1888, he started the manufacture of the Norton ball-bearing lifting jacks, produced in two factories, one in Boston and the other in Coaticook. Mr. Norton was the first to make non-fluid self-lowering jacks; he was also the pioneer in the making of ball-bearing screw jacks.

A. O. Norton

Corporal William A. Nugent, who served during the war in Company I, 21st Engineers, has returned from France, and resumed his duties with the Independent Pneumatic Tool Company, Chicago, as traveling representative. He has been assigned to his former territory in Indiana.

G. E. Scott, who for the past year and a half has been in the service of the American Red Cross at Washington, D. C., and from September, 1918, as general manager, has received his honorable discharge and resumed his duties as first vice-president of the American Steel Foundries, Chicago.

Albert Brunt, who for the past four years has been engineer in charge of the direct-current machine design section of the industrial engineering department of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has resigned to return to Holland, his native country.

Samuel O. Dunn has been elected a vice-president of the Simmons-Boardman Publishing Company, publishers of the *Railway Mechanical Engineer* and other publications, including the *Railway Age*, of which Mr. Dunn is editor-in-chief. His headquarters continue to be in Chicago.

Arthur S. Lewis, formerly with the Chicago, Cleveland Car Roofing Company and more recently with Flint & Chester, New York, has become associated with the Barco Manu-

facturing Company, Chicago, and will for the present be located at New York City, and cover Southern territory.

J. H. Redhead has been appointed assistant to the vice-president in charge of miscellaneous sales of the National Malleable Castings Company, Cleveland, Ohio. C. C. Gibbs, until recently associated with the sales department of the Indianapolis plant, has been appointed sales agent of the Cleveland plant, succeeding Mr. Redhead.

W. H. Woody, until April 17, 1919, supervisor of the shipfitters and allied trades at the government navy yard, Portsmouth, Va., and before enlistment in government work affiliated with the Chicago Pneumatic Tool Company, Chicago, as special representative, has been placed in charge of the Washington, D. C., office of the Keller Pneumatic Tool Company, Chicago.

F. P. Hoeck, superintendent of materials and stores of the International Railways of Central America, writes that the material department and commissary stores of his railroad requires new catalogues to replace those destroyed during the recent earthquake. Those desiring to furnish such catalogues are requested to send them to the purchasing department of the International Railways of Central America, 17 Battery place, New York, for enclosure.

Theodore L. Dodd & Company, 80 East Jackson boulevard, Chicago, have been appointed western sales representatives for the Worth Steel Company of Claymont, Del., manufacturers of high grade steel for railroad uses in connection with fireboxes and boilers. This company has a 160-in. mill with four 100-ton open hearth furnaces. It was formed by former members of the Worth Brothers Company of Coatesville, Pa., which concern was sold to the Midvale Steel Company several years ago.

George C. Isbester, district sales manager of the Rail Joint Company, with headquarters at Chicago, has resigned to become district sales manager of welded and weldless products for the American Chain Company, Inc., with headquarters at Chicago. Mr. Isbester was connected with the mechanical department of the Great Northern Railway at St. Paul, Minn., from 1897 to 1899, leaving the Great Northern at this time to go to the Sargent Steel Company, with headquarters at Chicago. He remained with this company until about 1902, when he went with the Q & C Company, with headquarters at Chicago, afterwards becoming vice-president of that company. In 1912 he left the Q & C Company to go with the Rail Joint Company as district sales manager, which position he held until his change as noted above. Mr. Isbester has been a director of the National Railway Applicances Association for several years until his resignation recently. During the war Mr. Isbester served in the United States Naval Reserve Forces as Lieutenant Commander, having been on active duty from April, 1917, until he was placed on the inactive list during May, 1919. He was recalled to active duty on July 28, 1919, to be sworn in as commander in the supply corps. He was selected for promotion from lieutenant commander to commander by the Board of Selection, and after receiving his promotion he was again detached from active duty. Commander Isbester has also served with the Illinois Naval Militia for ten years.

G. C. Isbester

The Chicago Pneumatic Tool Company announces the following changes: H. B. Barbee has been appointed manager of eastern railroad sales and Nelson B. Gatch district manager of sales, with headquarters at 52 Vanderbilt avenue, New York, to succeed L. C. Sprague, who is now manager of western railroad sales, with headquarters in Chicago. N. S. Thulin has been appointed a special railroad representative on Mr. Sprague's staff. T. J. Hudson, Jr., district manager at Chicago, is now manager of the pneumatic tool sales division.

Kenneth R. Hare has been appointed district manager for the Transportation Engineering Corporation, New York, with headquarters at Chicago, in charge of the territory in the middle west, including Chicago, St. Louis and other important railroad centers. Mr. Hare was graduated from the University of Wisconsin in 1911 with the degree of electrical engineer, having previously spent his vacations on railroad location and construction in Northern Minnesota, as concrete inspector and later in connection with transit and level work, estimates, etc. He also did considerable work in connection with the electrical construction, installation of dynamo electric machinery, transformers and switchboards for the Duluth Edison Company, and the General Electric Company. After graduation he took the test and shop course at the Schenectady works of the General Electric Company, following this, in 1912, with construction and meter work for the Great Northern Power Company, Duluth, Minn. Later, in the same year, he was appointed chief electrician for the Northern Pacific Railway, in charge of all electrical work from St. Paul to the Pacific Coast. In 1915 he was appointed associate editor, and later became managing editor of the Railway Electrical Engineer, published by the Simmons-Boardman Publishing Company, New York. He left this position in 1917 to enter military service as first lieutenant in the Ordnance Department. In 1918 he was appointed, on behalf of the government, assistant superintendent of the munition plant of the American Can Company, Kenilworth, N. J., in direct charge of the high explosive plant, remaining in that position until the work of the plant was about finished. He now becomes district manager of the Transportation Engineering Corporation, which is the authorized representative of the Edison Storage Battery Company in the sale of storage batteries to railroads, and of the Automatic Transportation Company in the sale of industrial trucks and tractors to railroads.

K. R. Hare

The American Steam Conveyor Corporation, Chicago, has established an office in the North American building, Philadelphia. H. S. Valentine has been appointed sales engineer in charge of the Philadelphia territory. He was formerly associated with the Link Belt Company, Philadelphia, for five and a half years, and with the Brown Hoisting Machinery Company and the Yale & Towne Manufacturing

Company for six years. Thomas O. Morgan, until recently head of the service department of the New York office of the company, has been promoted to the position of sales engineer and will cover Long Island and Connecticut territory.

The Q & C Company, with general offices at 90 West street, New York, announces the formation of The Q & C Packing & Lubricator Company, with general offices at the same address and a factory at 70 Pearl street, Jersey City, N. J. Charles F. Quincy is president of the new company; W. W. Hoit is vice-president, and F. F. Kister, treasurer, all of the present Q & C Company organization; S. S. Whitehurst, vice-president, and J. G. Smaltz, secretary, are now officials of Steele & Condict, Inc., Jersey City, N. J., where increased manufacturing facilities are being provided to care for the Q & C piston rod packing and lubricator.

Pratt & Lambert, Inc., Buffalo, N. Y., announces that its New York office at 185 Madison avenue, will be moved about November 1 to a new site in Long Island City, where a modern warehouse of brick construction, 200 ft. by 100 ft., consisting of two stories and basement, is now being built, not far from the Bridge Plaza. Donald L. Clement, former railway representative, who has recently returned from overseas service, will be assistant resident manager of the New York office. In order to increase the production at the main factory, Buffalo, a four-story brick building, 95 ft. by 45 ft., to be devoted to grinding, is to be put in service on October 1. At Bridgeburg, Ont., a four-story brick building, 85 ft. by 45 ft., is being erected in addition to new chimneys, double the size of the old, thinning buildings, filter buildings and other equipment which will triple the manufacturing capacity of the present factory.

Bertram Smith, assistant general sales manager of the Edison Storage Battery Company, Orange, N. J., has resigned to become president and general manager of the Automatic Electrical Devices Company, Cincinnati, Ohio. Mr. Smith has had more than 20 years' experience in the storage battery industry. He formerly served as secretary and treasurer of the old National Battery Company, which sold the Sperry plate, and after the absorption of this company by the United States Light & Heating Company, he was for a number of years manager of the western territory, with headquarters at Chicago. In 1913 he resigned to become assistant manager of the Edison Storage Battery Supply Company, with headquarters at San Francisco, and in 1915 was appointed manager of the Detroit sales district for the Edison Storage Battery Company. In September, 1918, Mr. Smith was made assistant general sales manager of that company, with headquarters at Orange.

The Norton Grinding Company and the Norton Company, both of Worcester, Mass., have been consolidated under the latter name. George I. Alden, who has been president of the Norton Company for some years, is chairman of the board of directors of the reorganized company; Charles L. Allen is president and general manager, Aldus C. Higgins, treasurer and general counsel and George N. Jeppson, secretary and works manager. Two new vice-presidencies have been created, one to be filled by W. LaCoste Neilson, vice-president and foreign manager, and the other by Carl F. Dietz, vice-president and general sales manager. A factory for the manufacture of abrasive products has been established in Japan and the company has acquired control of the Hiroshima Grinding Wheel Company, located at Hiroshima, near Kobe, Japan, which was established some years ago by the company's agents. Sales agencies have been established with native houses in several foreign countries, including England, France, Italy, Belgium, Denmark, Holland and like connections will be formed in Norway and Sweden. A new store at Detroit, Mich., has also been opened under the management of C. W. Jinnette.

CATALOGUES

Ventilators.—A six-page folder has been issued by the Garland Ventilator Company, Chicago, briefly describing and illustrating by means of drawings some of the best known and most widely used types of Garland railway car ventilators.

Electric Traveling Cranes.—A new catalogue of Chesapeake cranes has been compiled by the Chesapeake Iron Works, Baltimore, Md. The book contains 28 pages, 9 in. by 11½ in. The first half is devoted to descriptions and illustrations of the various parts of the cranes, while the last half contains full page illustrations of installations.

Curtain Roller.—The Curtain Supply Company, New York, is revising its catalogue, which will hereafter be issued in the form of bulletins describing and illustrating their various products. The first of these, R-2, covers the Rex all-metal curtain roller and consists of eight pages, describing the construction of the roller and illustrating the detail parts.

Flange Lubrication.—A flange oiler which is simple in construction, having two working parts, said to be easily applied, to eliminate slipping and to require no attention, is being placed on the market by J. H. Miner of Lumberton, Miss. This he describes in a booklet of eight pages.

Storage Battery Cars.—Typical installations of Edison equipped railway storage battery cars are shown in Bulletin 106, consisting of 16 pages and issued by the Edison Storage Battery Car Company, New York. Illustrations show cars in service in various parts of the United States, Central and South America, Mexico and Alaska. A short analysis is included of the relative costs of storage battery and steam operation on the Long Island Railroad and the Edison nickel-iron-alkaline storage battery is described.

Vulcan Soot Cleaner.—Bulletin 541, issued by the Vulcan Soot Cleaner Company, Du Bois, Pa., contains a discussion of the merits of the Vulcan patented diagonal method for cleaning soot from the tubes of horizontal water tube boilers, covering such features as maintenance cost and first cost, accessibility for inspection and repairs and ease of installation and cleaning. Illustrations in two colors show typical designs as applied to horizontal water tube boilers with vertical baffling. The bulletin also contains an analysis of the cost of Vulcan cleaners and their value as investments.

Whiting Railroad Equipment.—The Whiting Foundry Equipment Company, Harvey, Ill., has prepared Catalogue 145, containing 36 pages, to show the advantages and labor saving features of the various railroad specialties manufactured by this company. The equipment described in this catalogue consists of screw jack locomotive and coach hoists, transfer tables for locomotives and coaches, cranes and turntable tractors. For those contemplating new shops a drawing of a modern shop layout, showing the most practical and economical arrangement of the equipment, is included.

Hydraulic Machinery.—A catalogue of 63 pages, embracing all kinds of hydraulic machinery, has been prepared by William H. Wood, hydraulic engineer, Media, Pa. These machines include flanging, riveting, punching and shearing machines, cranes, hammers, valves, pumps, accumulators, etc. Several drawings are also shown of the Wood's flexible corrugated locomotive firebox and a summary of the results of comparative tests, made some years ago on the New York Central, of a Wood's firebox with arch tubes and a standard firebox without arch tubes.